The American Journal of Surgery

EDITED BY THURSTON SCOTT WELTON, M.D.

June 1943

Obstetrics . Gynecology

General Surgery . Orthopedics

Anesthesia . Gastrointestinal Surgery

Fifty-second Year of Continuous Publication

The American Journal of Surgery, Inc.

49 WEST FORTY-FIFTH STREET · NEW YORK

EDITORIAL BOARD

The American Journal of Surgery

Editor THURSTON SCOTT WELTON, *New York*

ASSOCIATE EDITORS

FRED H. ALBEE, *New York*
CARL BECK, *Chicago*
CLAUDE S. BECK, *Cleveland*
GEORGE R. BRIGHTON, *New York*
MEREDITH F. CAMPBELL, *New York*
JAMES T. CASE, *Chicago*
ISIDORE COHN, *New Orleans*
BRADLEY L. COLEY, *New York*
FREDERICK A. COLLER, *Ann Arbor*
PAUL C. COLONNA, *Philadelphia*
ELLIOTT C. CUTLER, *Boston*
CHARLES A. ELSBERG, *New York*
HERBERT C. FETT, *Brooklyn*
JOHN H. GIBBON, *Philadelphia*
EMIL GOETSCH, *Brooklyn*
CHARLES A. GORDON, *Brooklyn*
DONALD GUTHRIE, *Sayre, Pa.*
ARTHUR E. HERTZLER, *Kansas City*
LOUIS J. HIRSCHMAN, *Detroit*
JAMES M. HITZROT, *New York*
FREDERICK C. HOLDEN, *New York*
EMILE F. HOLMAN, *San Francisco*
JOHN E. JENNINGS, *Brooklyn*
WILLIAM L. KELLER, *Washington*
New York, THOMAS J. KIRWIN
New York, ARTHUR KRIDA
New York, ADRIAN V. S. LAMBERT
New York, MAURICE LENZ
New York, H. H. M. LYLE
New York, JEROME M. LYNCH
New Orleans, URBAN MAES
Newark, HARRISON S. MARTLAND
New Orleans, RUDOLPH MATAS
Detroit, ROY D. MCCLURE
San Francisco, H. C. NAFFZIGER
Baltimore, EMIL NOVAK
Newark, CLARENCE R. O'CROWLEY
Boston, LOUIS E. PHANEUF
New York, EUGENE H. POOL
Rochester, Minn., JAMES T. PRIESTLEY
New York, DOUGLAS QUICK
Brooklyn, NATHANIEL P. RATHBUN
Raleigh, HUBERT A. ROYSTER
Philadelphia, HENRY S. RUTH
St. Louis, M. G. SEELIG
New York, J. BENTLEY SQUIER
New York, H. J. STANDER
Baltimore, GRANT E. WARD
San Francisco, J. HOMER WOOLSEY

The American Journal of Surgery is published monthly by the American Journal of Surgery, Inc., 49 West 45th Street, New York, N. Y. Yearly Subscription, $10.00 U. S. A.; $15.00 Canada; $12.00 Foreign. Single Numbers $2.00; Special Numbers $4.00. Entered as second class matter August 28, 1926, at the Post Office, New York, N. Y., under the act of March 3, 1879. June, 1943—New Series, Volume LX, No. 3.

VALID CLAIMS

. . . proof which spans the chasm between

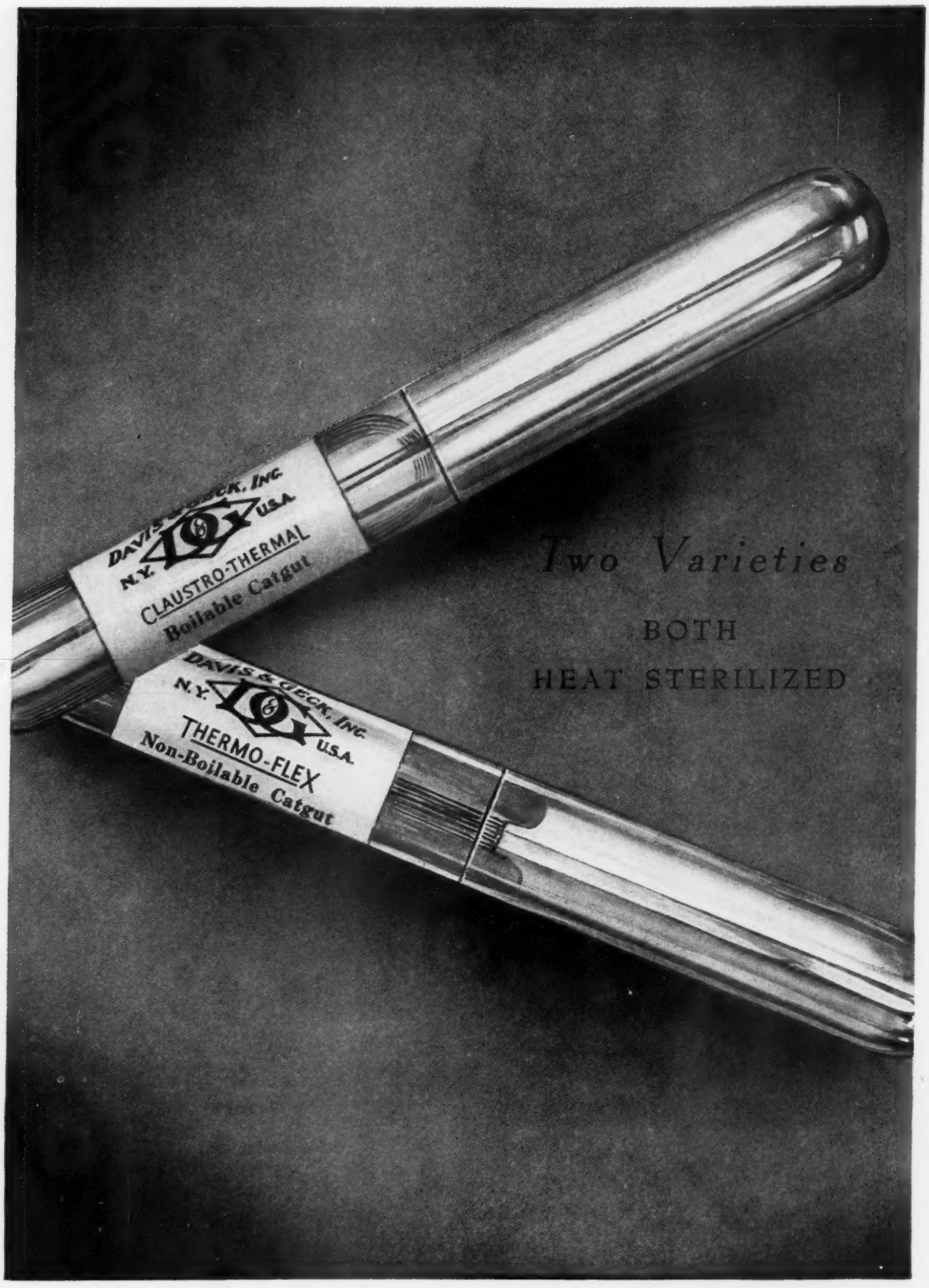
yesterday's unexplored theories

and today's factual news

IT IS the conviction of those who guide the destiny of Davis & Geck Sutures that accurate knowledge of the properties and clinical latitude of a selected suture is essential to successful attainment of the surgical objective . . . Claims made for *D&G* products are therefore scrupulously limited to facts fully substantiated by clinical evidence . . . This uncompromising policy is implemented by facilities for conducting any form of investigation required to define clearly the merits and application of new suture developments *before* presenting them to the profession.

DAVIS & GECK·INC

"THIS ONE THING WE DO"



SINCE 1909 — *Surgical Sutures Exclusively*

Claustro-thermal Catgut

POSSESSES all the qualities essential to proper function and is adaptable to all conditions and technics. Tubes may be boiled or autoclaved or treated germicidally for asepticization of their outer surfaces.

This catgut offers the additional safety factor of CLAUSTRO-THERMAL* sterilization —an exclusive D&G process wherein heat, at temperatures lethal to the most resistant spores and organisms, is applied *after* the suture is hermetically sealed in its glass tube and thus fully protected.

Being completely stable the suture is unaffected by age, climate, light or by the reboiling or autoclaving of unused tubes. Its hydroscopicity makes flexibility easily regulated to meet individual preferences or specific requirements.

Thermo-flex Catgut

FLEXIBILITY is the feature of this catgut — the maximum flexibility practical without sacrifice of other equally essential characteristics. Ready for use as it comes from the tubes, it requires no moistening or special preparation.

Though of the non-boilable type, there is no compromise in sterility. It is sterilized by *heat* at temperatures exceeding the most rigid bacteriologic requirements.

Its moisture content is normal and therefore it lacks the tendency towards progressive deterioration in strength typical of water-logged catgut. It is unaffected by age, climate, or light.

D&G THERMO-FLEX* catgut represents that fine balance of qualities so vital to correct function and utmost dependability.

Fine-gauge Catgut

UNPRECEDENTED in its smallness of diameter this material is comparable in size to fine silk, yet it provides the distinct advantage of absorbability. Moreover, it may be used freely without special technics or sacrifice of operating time. Exceptional strength and resistance to absorption make it applicable to a wide range of procedures, facilitating accurate apposition and providing prolonged retention with marked reduction in trauma. Available in both boilable and non-boilable varieties.

DAVIS & GECK SUTURES WITH ATRAUMATIC NEEDLES FOR SPECIFIC PROCEDURES

Intestinal *Thyroid* *Tonsil* *Eye* *Harelip*
Cleft Palate *Plastic* *Nerve* *Artery* *Obstetrical*
Circumcision *Ureteral* *Renal*

A LIST OF SIZES, LENGTHS, SUTURE-NEEDLE COMBINATIONS AND PRICES WILL BE SENT ON REQUEST

* D&G Registered Trade Mark

The Rationale of Suture Use

BRIEF DISCUSSIONS BASED ON REPORTS OF CURRENT RESEARCH AND CLINICAL OBSERVATION

Tension Sutures

TENSION SUTURES are employed to reinforce and protect the primary suture line. Their function is to absorb sudden strains and to prevent unusual forces from pulling on the primary sutures as well as to obliterate "dead spaces" in the subcutaneous fat. Hence they should be accurately spaced and placed well back from the wound edges.

On these points there is general agreement, but opinion differs both as to the merits of respective forms of tension sutures and the tissues they should include. The circular type is the most widely used. However, some feel that the bolt type resists strains more effectively on the theory that, under tension, the circle flattens into an oval permitting the lateral points of fixation to move outward.

Of those using the circular type some place them only through the anterior sheath of the rectus muscle while others extend them beneath the muscle catching the suture line of the peritoneum and posterior rectus sheath.

Logic favors the latter, for a tension suture which penetrates only as deep as the anterior rectus sheath can hardly relieve strains upon the suture line of the underlying structures—yet it is in this deeper layer that disruption starts.

Although much has been written on the subject of wound disruption, the extent to which tension sutures prevent it is still unsettled. There are several reasons for this.

First—statistics seldom specify the form of tension suture employed. As has been pointed out, some types cannot conceivably prevent disruption.

Next—false impressions have been created by statistics showing that of a given number of disrupted wounds, as many had been sutured with tension sutures as without them. The efficacy of tension sutures cannot be analyzed in this way. It can only be judged by the ratio of disruptions to the total number of wounds originally closed with or without tension sutures.

Moreover, such analysis will be meaningless unless the comparisons are made in similar types of wound. Certain wounds such as those made to repair inguinal hernia seldom disrupt and transverse incisions disrupt less frequently than longitudinal ones. Infected wounds must be excluded because of their tendency to disrupt.

Discussions of fourteen subjects in this series on Suture Use have been published. Reprints (including the above) and a bibliography will be sent on request.

DAVIS & GECK, INC., *Brooklyn, N. Y.*

BEFORE THYROIDECTOMY

Iodine reactions, an ever-present threat during the presurgical preparation of the thyroid patient, need not be considered when Amend's Solution is prescribed. Being virtually nontoxic, Amend's Solution is well-tolerated, even by patients who are known to be sensitive to iodine in other forms.

In many instances in which Lugol's solution and the iodides caused toxic reactions and necessitated withdrawal, Amend's Solution, immediately instituted, not only was well borne but led to rapid disappearance of all signs of iodine intoxication.

Amend's Solution, resublimed iodine largely in organic form, in a stable, aqueous (1.21%) solution, is safer because its iodoprotein molecule breaks down slowly, and is absorbed at a gradual sustained rate. Thus it avoids the stormy fluctuation of blood iodine levels in many quarters considered the cause of iodine intoxication.

Thos. Leeming & Co. Inc.

155 East 44th Street New York, N. Y.

Amend's SOLUTION

The American Journal of Surgery, Inc.

Reg. U. S. Pat. Off., Nov. 3, 1936

NEW SERIES VOL. LX — *Contents • June, 1943* — NUMBER THREE

Editorials

Use of Color in the Operating Room . . . . . *Richey L. Waugh and Esther M. Welch* 309

Neglected Point in Burn Therapy . . . . . *Major Edward F. McLaughlin* 311

Original Articles

Surgical Operations with the Navy Medical Corps in the South Pacific . . . *Lieut. Comdr. W. M. Johnston* 313

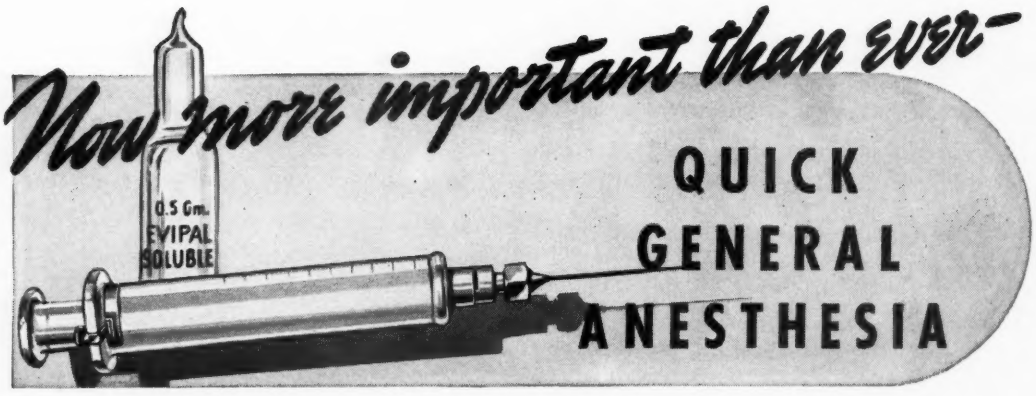
Intra-abdominal Injuries . . . . *Costabile Di Lorenzo, Milton Rothman and Clarence Howley* 319

Solitary Cyst of the Kidney. Report of Two Cases . . . . . *Lowrain E. McCrea* 328

Theory and Therapy of Shock. Reduced Temperatures in Shock Treatment . *Frederick M. Allen* 335

New Operation for the Repair of the Crucial Ligaments of the Knee . . . . . *Fred H. Albee* 349

Contents Continued on Page 3



INTRAVENOUS ANESTHESIA occupies an important place in military medicine. The method offers the advantages of ease of administration, speedy induction and quick recovery. The anesthetic agent is easily transported and remains stable indefinitely under a wide variety of conditions. Moreover, intravenous anesthesia may be used in conjunction with other forms of anesthesia (infiltration, regional, spinal) and often when gas or ether is contraindicated.

Evipal Soluble—intravenous anesthetic—is employed for numerous surgical procedures, change of dressings and painful examinations that can be performed within a relatively short period of time (from twenty to thirty minutes). *Pamphlet containing detailed information will be sent free to physicians on request.*

WINTHROP CHEMICAL COMPANY, INC.

Pharmaceuticals of merit for the physician

NEW YORK, N. Y.
WINDSOR, ONT.

ARMY E NAVY

This cherished symbol of distinguished service to our Country waves from the Winthrop flagstaff.

HOW SUPPLIED: Evipal Soluble is supplied in ampuls of 0.5 Gm. and 1 Gm. of the powder, boxes of 1 each, with an ampul of sterile distilled water. Also in ampuls of 0.5 Gm. of the powder, boxes of 10, and ampuls of 1 Gm., boxes of 10 and 25, without distilled water.

Evipal Soluble

"Evipal" Reg. U. S. Pat. Off. & Canada

Brand of HEXOBARBITAL SOLUBLE

(Sodium salt of N-methylcyclohexenylmethyl barbituric acid)

The American Journal of Surgery

NEW SERIES VOL. LX — Contents • June, 1943 — NUMBER THREE

Control of Acute Thrombophlebitis with Ultraviolet Blood Irradiation Therapy . *George Miley* 354

Tobacco Smoking and Cancer of the Lung . . . . . *Edwin J. Grace* 361

Value of Auscultation of the Abdomen in the Diagnosis of Acute Appendicitis . *N. C. Stevens* 365

Experimental Osteomyelitis . . *Louis Scheman, Philip Lewin, Sidney Sideman and Martha Janota* 371

New Treatment for Acute Dilatation of the Stomach . . . . . *Edward G. Joseph* 381

Dangers of Boric Acid. Its Use as an Irrigant and Report of a Case . . . . *Charles A. Ross and John F. Conway* 386

Continuous Caudal Anesthesia. Preliminary Report of a Newly Modified Technic *A. Charles Posner and Irwin M. Buch* 396

Caudal Anesthesia in Obstetrics . . . . . *A. C. Mietus and R. M. Mitchell* 399

Avertin Anesthesia in Gynecology. Report on a Series of Cases . . *Lieut. Daniel B. Dorman* 403

Bacillus Proteus OX19 Agglutinated by the Serum of Pregnant Women. Preliminary Report . . . . . *I. Gratch* 411

Comparison of Tissue Reactions from New Sutures . . . . . *Octavus P. Large* 415

Case Reports

Instrumental Intestinal Trauma during Laparotomy. Sponge and Tissue Forceps Injuries . . . . . *Harrison S. Martland* 424

Water Blast Injury. Report of Two Unusual Cases. *Comdr. H. L. Pugh and Lieut. R. M. Jensen* 429

Typhoid Osteomyelitis. Case Report . . . . *Graham A. Kernwein and Richard B. Capps* 433

Actinomycosis of the Liver and Lungs . . . . . *Roland T. Smith* 438

Meckel's Diverticulum as a Cause of Intestinal Obstruction. Report of a Case of Volvulus . . . . . *Milton Rothman and Dominick F. Zetena* 443

Glioblastoma Multiforme. Report of Three Cases *Henry Ward Williams and William P. E. Berwald* 447

Successive, Coexistent Tubal Pregnancies. Case Report *R. M. Mitchell and Lawrence Kurzrok* 450

Rat-bite Fever. Case Report . . . . . *Samuel B. Burk and Joseph H. Hodas* 453

Author Index to Volume LX 455

Subject Index to Volume LX 456

General Information on Page 4 *Advertising Index on 3rd cover*

General Information

THE AMERICAN JOURNAL OF SURGERY does not hold itself responsible for any statements made or opinions expressed by any contributor in any article published in its columns.

Articles are accepted for publication with the understanding that they are original contributions never previously published. All manuscripts are subject to editorial modification, and upon acceptance become the property of THE AMERICAN JOURNAL OF SURGERY, INC.

A reasonable number of illustrations are supplied free of cost; special arrangements must be made with the editor and publishers for excess illustrations and elaborate tables.

Reprints are furnished on order. Prices are quoted when articles are in page form.

Material published in THE AMERICAN JOURNAL OF SURGERY is copyrighted and may not be reproduced without permission of the publishers.

Change of address must reach us by the 15th of the month preceding month of issue.

PREPARATION OF MANUSCRIPTS

Text. Manuscripts are to be typewritten, on one side of the paper, with double spacing and good margins. The original should be sent to the editor and a carbon copy retained by the author.

Illustrations. Illustrations must be in the form of glossy prints or drawings in black ink (*never* in blue). On the back of each illustration the figure number, author's name and an indication of the top of the picture should be given. Legends for illustrations are to be typewritten in a single list, with numbers corresponding to those on the photographs and drawings. Please do not attach legends to the pictures themselves.

Bibliographies. Bibliographic references should be at the end of the manuscript, in alphabetical order, and not in footnotes. Each reference should include the following information in the order indicated: Name of author with initials; title of article; name of periodical; volume, page and year. The following may be used as a model:

PHANEUF, LOUIS E. Indications and technique. *Am. J. Surg.*, 25: 446, 1937.

The author should always place his full address on his manuscript.

The subscription price of THE AMERICAN JOURNAL OF SURGERY, is $10.00 per year in advance in the United States; $15.00 in Canada; and $12.00 in foreign countries. Current single numbers $2.00. All Special Numbers $4.00. Prices for such back numbers as are available will be quoted on request.

Address all correspondence to

The American Journal of Surgery, Inc.

49 WEST 45TH STREET · NEW YORK

To reduce the chance of by-effects

Pantopon 'Roche' contains *all* the active alkaloids of opium — not merely morphine. These alkaloids are present in the same proportion as nature provides them in the poppy, but free from gums, resins, and inert materials. In such combination the therapeutic principles seem to have a natural balance that provides smoother opiate action, reducing the chance of by-effects so commonly encountered when morphine alone is used. That is why Pantopon has been adopted as a routine opiate by so many leading physicians in the various fields of medicine and surgery. When opiate medication is indicated, try ⅓ gr. of Pantopon 'Roche' instead of the usual ¼ gr. of morphine. HOFFMANN-LA ROCHE, INC., ROCHE PARK, NUTLEY, NEW JERSEY.

USE PANTOPON 'ROCHE' IN PLACE OF MORPHINE

FOR ALL 3 ESSENTIAL SERVICES . . .

1 PRODUCTION OF PARENTERAL FLUIDS

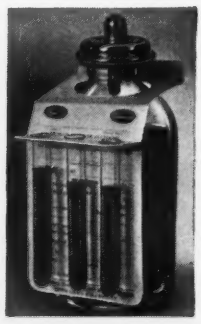
2 COLLECTION OF WHOLE BLOOD

3 PREPARATION OF HUMAN BLOOD PLASMA

The FENWAL SYSTEM*

offers the utmost in safety, maximum convenience and simplicity, marked economy.

*An approved equipment for hospitals participating in the OCD program.



Fenwal Containers, Teloseal and Telovac closures are REUSABLE.

Just off the press . . .

Describes in detail the operation and care of equipment • formulae • suggested technics for preparation, processing, storing and administration.

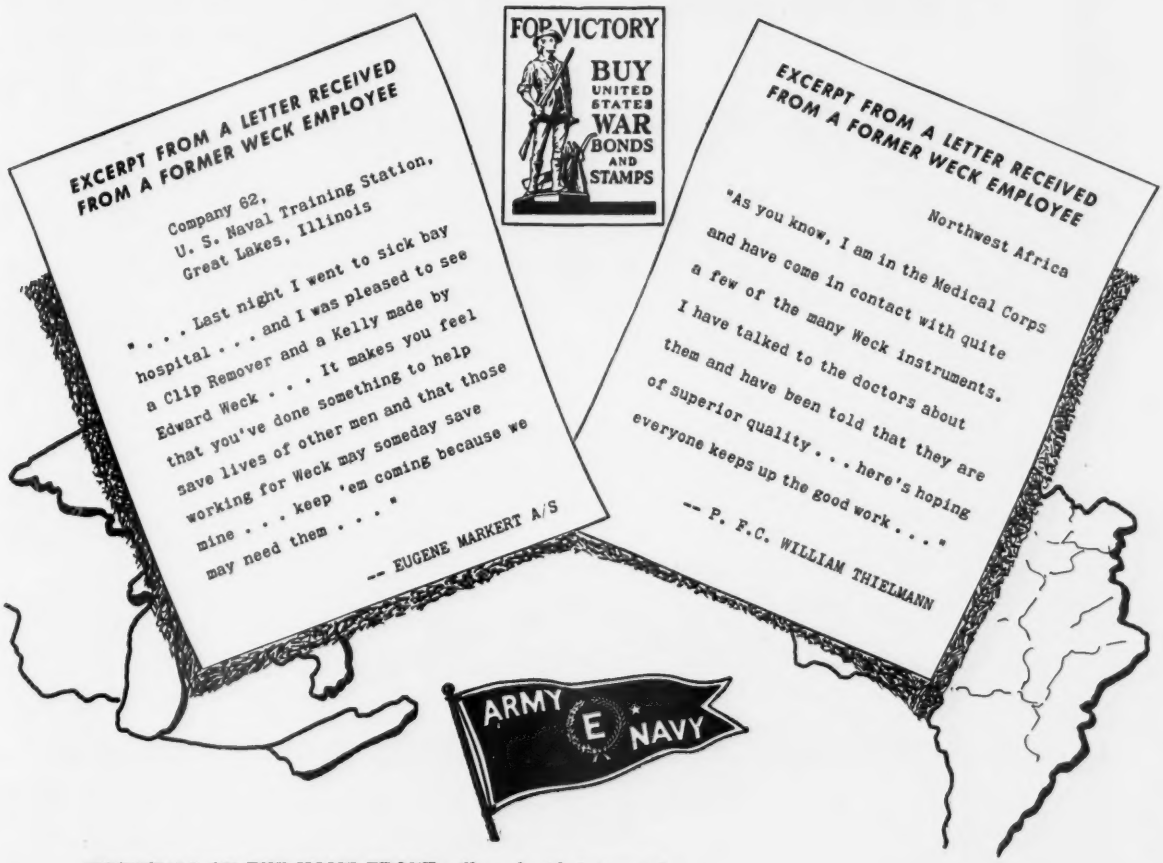
SEND FOR YOUR COPY TODAY

Fenwal

MACALASTER BICKNELL COMPANY

243 BROADWAY CAMBRIDGE, MASSACHUSETTS

Good Advice FROM TRAINING CAMPS AND NORTH AFRICAN FRONT


EXCERPT FROM A LETTER RECEIVED FROM A FORMER WECK EMPLOYEE
Company 62,
U. S. Naval Training Station,
Great Lakes, Illinois
". . . . Last night I went to sick bay hospital . . . and I was pleased to see a Clip Remover and a Kelly made by Edward Weck . . . It makes you feel that you've done something to help save lives of other men and that those working for Weck may someday save mine . . . keep 'em coming because we may need them . . . "
-- EUGENE MARKERT A/S
FOR VICTORY
BUY
UNITED
STATES
WAR
BONDS
AND
STAMPS
EXCERPT FROM A LETTER RECEIVED FROM A FORMER WECK EMPLOYEE
Northwest Africa
"As you know, I am in the Medical Corps and have come in contact with quite a few of the many Weck instruments. I have talked to the doctors about them and have been told that they are of superior quality . . . here's hoping everyone keeps up the good work . . . "
-- P. F.C. WILLIAM THIELMANN
ARMY
E
NAVY

HOSPITALS ON THE HOME FRONT will read with interest the excerpts above from two of the several Weck craftsmen now in our armed forces. On all fronts — training camps, North Africa, Europe, the Far East, Weck surgical instruments are serving on a constantly widening circle. Surgeons everywhere find the words of these Weckmen wise — "keep 'em coming." Day and night, week in and week out, for two years Weck has been working to do just that. If you find difficulty in getting all the Weck-made instruments you need we know you will cooperate with us — the needs of our men on all fighting fronts must come first. Meanwhile, perhaps the Weck repair service can aid you; and finally the best advice of all: BUY MORE U. S. WAR BONDS AND STAMPS.

WECK
CRODON
The Chrome Plate

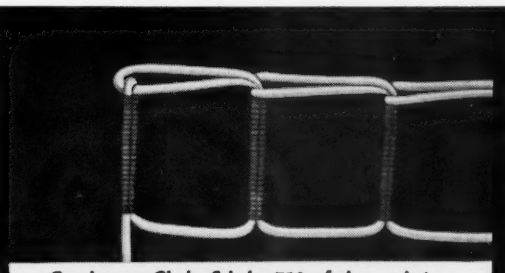
Edward Weck & Co., Inc.

Manufacturers Surgical Instruments

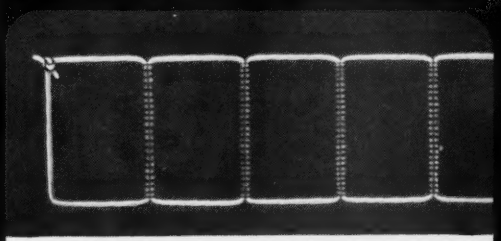
SURGICAL INSTRUMENT REPAIRING · HOSPITAL SUPPLIES

135 Johnson Street Brooklyn, N.Y.

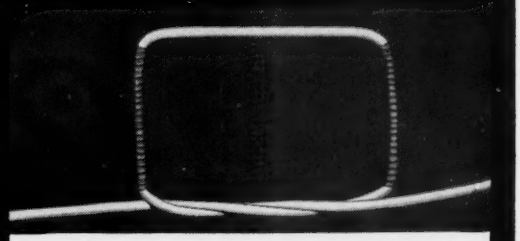
AN IMPROVED SUTURING TECHNIQUE AT YOUR FINGERTIPS



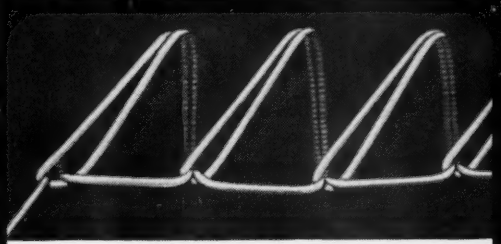
Continuous Chain Stitch—750 of these stitches can be made with 50 feet of C silk.



Lock Stitch—Simple, continuous—exerts pressure on sides of incision. Affords more patient comfort.



Interrupted Chain creates pressure on sides of incision rather than across incision.



Double Triangle—While effecting complete closure this stitch allows great surface flexibility.

Purse String—Over 700 of these stitches can be made without rethreading.

THE SINGER SURGICAL STITCHING INSTRUMENT offers surgeons a variety of new interrupted and continuous stitches in addition to sutures now in common use, insuring more complete and effective closure, more postoperative comfort for patients because of better juxtaposition of wound edges which results in less scar.

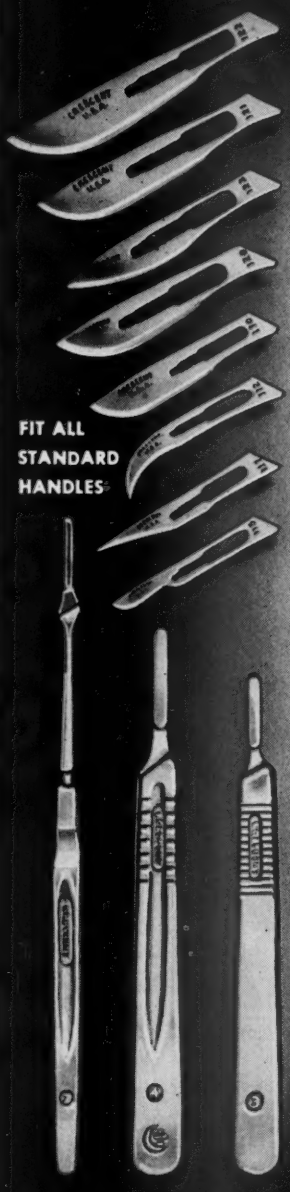
One spool of size O silk is sufficient to form from 100 to 700 stitches without rethreading or reclamping. The SINGER SURGICAL STITCHING INSTRUMENT uses any standard suture material and its suture capacity, plus the ease at which the needle may be set at any of eight different positions, places at the disposal of surgeons an instrument with possibilities limited only by individual ingenuity. Write for brochure giving detailed information.

SINGER
Surgical Stitching
INSTRUMENT

The Singer Surgical Stitching Instrument can be sterilized as a unit. It is quickly taken apart for cleaning and may be reassembled in one minute.

SINGER SEWING MACHINE COMPANY • 149 BROADWAY, NEW YORK, N.Y.

For SURGERY as a Fine Art...



FIT ALL STANDARD HANDLES

AS the Strad is to the violin virtuoso, or brilliant pigments to a Leonardo, so are Crescent Surgical Blades to the meticulous operator—their special qualities an integral part of his technical artistry.

With Crescent blades, he works with an extra *sharpness*, ground in by a sharper, more acute bevel of the cutting edge.

For the sureness of his incision (without weaving), he can rely on a *rigidity* that is "built in" every Crescent blade, with one-third more of the finest steel.

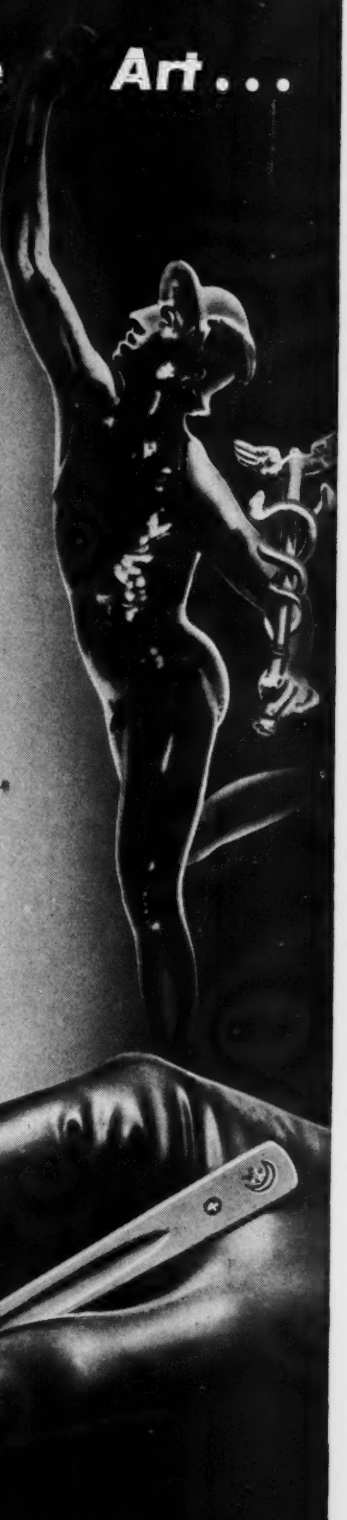
And his manual dexterity is facilitated by the *balanced* distribution of weight, without thinning down from the back.

In creating masterworks of surgical skill, you can depend on Crescent—the instrument of discriminating choice.

For samples, call your surgical dealer—or write to

CRESCENT SURGICAL SALES CO., Inc.
NEW YORK, N. Y.

"The master hand deserves a master blade"



Crescent

SURGICAL BLADES AND HANDLES

Backed By 73 Years of Research . . .

CHAMPION

Moisture and Serum Proof

SILK SUTURES

★ Due to 73 years' continuing research, Champion Sutures rank with the finest sutures in the world today. This is attested by their widespread acceptance on all fighting fronts in the present war. In virtually all parts of the globe, Champion Sutures are aiding greatly in the rehabilitation of the Nation's wounded Soldiers, Sailors and Marines. Luckily, there will be adequate supplies of Champion Sutures available for civilian use throughout the duration.

NOTE THESE ADVANTAGES:

- ★ Free from absorption of germs.
- ★ Non-acid. Non-irritating.
- ★ Benign to tissue.
- ★ Does not adhere to skin or tissue.
- ★ Fine diameters with greater strength permit the use of smaller sizes, resulting in lessened trauma.
- ★ Maintain strength.
- ★ Withstand repeated sterilization.

★ **Made in 15 sizes—a size for every type of surgery.**

Free operating lengths will be gladly furnished on request.

GUDEBROD BROTHERS SILK CO., INC.

12 SOUTH 12TH STREET, PHILADELPHIA

Boston New York Founded 1870 Chicago Los Angeles

Sulfa Drugs Blood Plasma Sklar Instruments

THE great skill of today's military surgeons is made possible by such marvelous aids as the sulfa drugs and human blood plasma. Also helping their deft hands is the finest equipment.... Sklar surgical instruments, for example. Wherever the surgeons of our armed forces stand by for action you are pretty sure to find Sklar products. Sklar quality has always been based on the vital role these instruments play. Perhaps that is why so many of them are today "in uniform" for the United Nations.

ARMY E NAVY

J. SKLAR MANUFACTURING COMPANY
LONG ISLAND CITY, N. Y.

LINN BALL

THE U. S. NAVY IN ACTION

Instruments for civilian use are not abundant—protect and conserve those you have. We will do our very best to fill your absolute requirements. There will be plenty after V-Day.

Quoted

from one of more than 400 published papers

"Sodium pentothal has no deleterious effects on renal function or the retention of nitrogenous products in the blood. A study was carried out on more than 50 cases to determine whether there was an increase in the nitrogenous products in the blood postoperatively as compared with the preoperative findings, and no appreciable change was noted. The drug apparently is not excreted by the kidney, since none has ever been found in the urine."

J. M. Townsend
The Use of Pentothal Sodium In Urological Surgery.
Jour. of Urology, 47:235, Mar., 1942

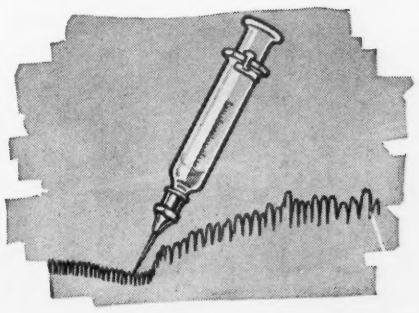
FOR INTRAVENOUS ANESTHESIA

Pentothal Sodium

REG. U.S. PAT. OFF.

[SODIUM ETHYL-(1-METHYL-BUTYL)-THIOBARBITURATE, ABBOTT]

Descriptive literature will be sent upon request. Address inquiries to
ABBOTT LABORATORIES
North Chicago, Illinois



For a Rapid, Sustained Rise

in blood pressure without appreciable cardiac depression or cerebral stimulation

Neo-Synephrine

Hydrochloride

(laevo—alpha—hydroxy—beta—methyl—amino—3 hydroxy ethylbenzene hydrochloride)

ACCEPTED AMERICAN MEDICAL ASSN Council on Pharmacy and Chemistry

Supplied in 1 c.c. ampules, and in rubber-capped vials containing 5 c.c. of a sterile 1% solution. Average subcutaneous dose: 0.5 c.c.

Frederick **Stearns** & Company

Since 1855 . . . ESSENTIALS OF THE PHYSICIAN'S ARMAMENTARIUM

NEW YORK KANSAS CITY **DETROIT, MICH.** SAN FRANCISCO WINDSOR, ONTARIO
SYDNEY, AUSTRALIA AUCKLAND, NEW ZEALAND

VACUUM-
PROTECTED
BAXTER
INTRAVENOUS
THERAPY

THE *visible proof of vacuum* clearly carried by every Vacoliter is a valuable index of the safety of Baxter Intravenous Solutions—an exclusive Baxter feature. The two indentations in the protective rubber disc show you before use that Baxter Solutions are as pure, as sterile, as pyrogen-free as the day they passed the 21 rigid chemical, bacteriological, and chemical tests and inspections which are routine for every liter. Of equal importance is Baxter's mechanically induced vacuum in Transfuso-Vacs, Centri-Vacs, and Plasma-Vacs. It is a necessity for a closed technique for blood collection, invaluable in plasma and serum aspiration, and vital to safe storage. ☆ Vacuum-protected intravenous therapy, as originated and perfected by Baxter, is simple, economical, and *safe*.

PRODUCTS OF
BAXTER LABORATORIES
Glenview, Illinois • College Point, New York • Acton, Ontario • London, England
PRODUCED AND DISTRIBUTED IN THE ELEVEN WESTERN STATES BY DON BAXTER, INC., GLENDALE, CALIFORNIA
Distributed east of the Rockies by
AMERICAN HOSPITAL SUPPLY CORPORATION
CHICAGO • NEW YORK

"The Old One-Two..."

IN SPORTING PARLANCE the fellow who can successfully stand up against "the old one-two" wins the fight. In the Squibb Laboratories Cyclopropane likewise must stand up when given "the old one-two"—(1) Chemical Analysis, and (2) Biological Test.

The *chemical analysis* governs the selection of raw materials, the purification methods used, as well as the purity of the finished product.

The *biological control test* to which Cyclopropane Squibb is subjected is employed as a further safeguard of quality. In this test we try to approximate human anesthesias. The carbon dioxide absorption technique is employed on unpremedicated rhesus monkeys for two-hour periods. Careful observation is made of induction time, speed of recovery, circulatory and respiratory effects, muscular relaxation, amount of lacrimation and salivation, and any unusual side effects. Samples of the anesthetic mixture are taken at regular intervals throughout the anesthesia for determination of percentage concentration of Cyclopropane, oxygen and carbon dioxide.

These tests safeguard the high purity of Cyclopropane Squibb. Its high quality has been demonstrated by extensive clinical experience in many of the leading hospitals and it is a brand of choice with many anesthetists throughout the country.

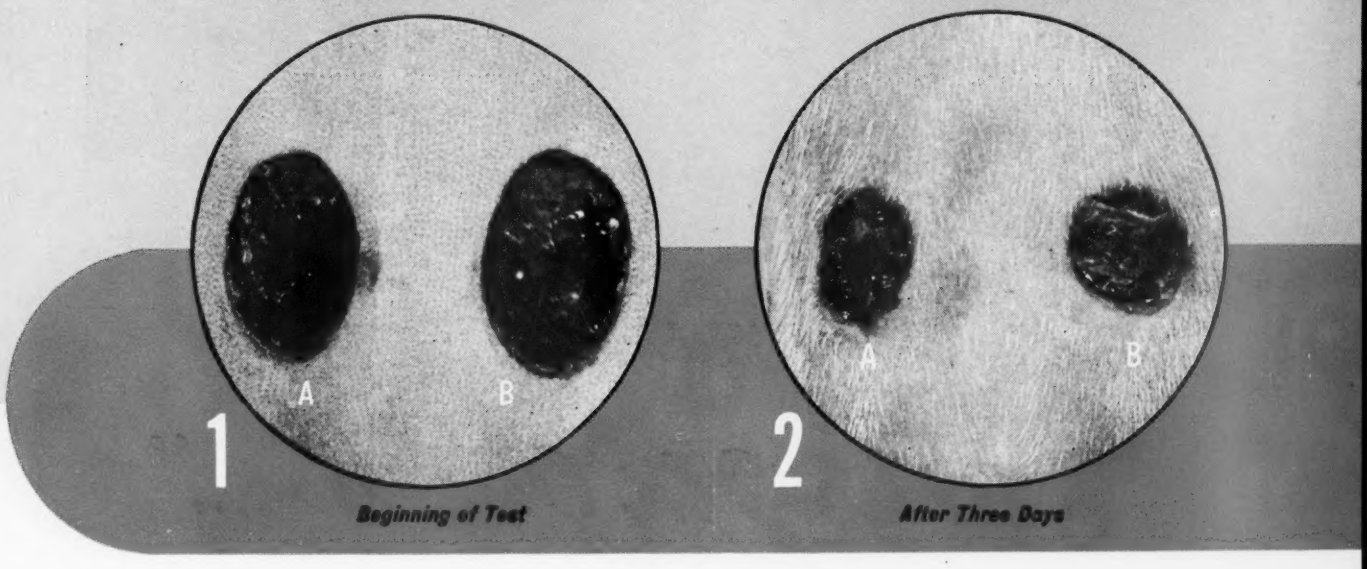
Cyclopropane Squibb is available in 40 (AA); 100 (B); and 200 (D) gallon special light-weight steel cylinders . . . easier to handle . . . less costly to ship.

For literature, address Anesthetic Division, 745 Fifth Avenue, New York.

E·R·SQUIBB & SONS

Manufacturing Chemists to the Medical Profession Since 1858

THIS POWERFUL GERMICIDE DOES NOT INTERFERE WITH HEALING



AN OUTSTANDING characteristic of this new non-mercurial germicide is its complete lack of interference with the healing process—a fact that has been established both experimentally and clinically.

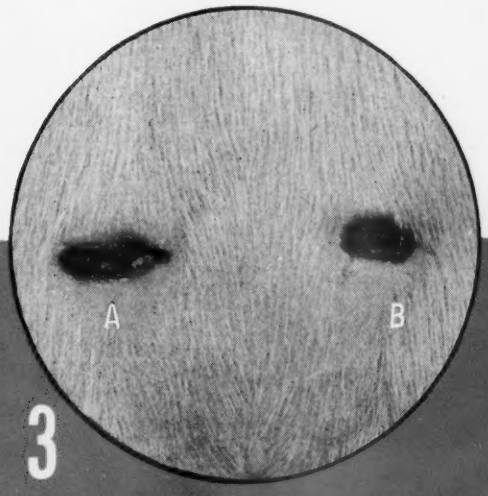
Ceepryn, a quaternary ammonium salt, is a distinctive advance in the antiseptic field, combining exceptionally high, non-selective bactericidal activity with negligible tissue toxicity.

Equally important are the penetrating and detergent properties of Ceepryn, which permit it to enter into, disinfect and cleanse folds of the mucosa and crevices and pores of tissue and skin.

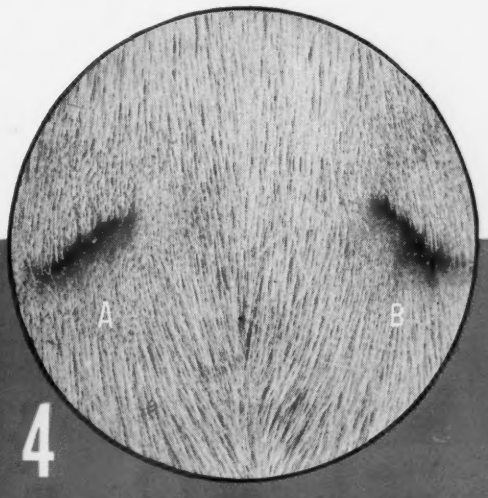
Ceepryn not only provides superior bactericidal and cleansing action, but is free from the irritating and corrosive effects of many commonly employed germicides such as iodine, phenol and cresol. It overcomes the chief limitations of the mercury salts, being considerably more potent in high dilutions, more active in presence of organic matter, much higher in penetrating ability and significantly lower in toxicity. It is superior to the active chlorine derivatives both in germicidal activity and stability.

CEEPRYN

BRAND OF CETYLPYRIDINIUM CHLORIDE



After Seven Days



After Sixteen Days—Complete Healing of Both Areas

CLINICAL ADVANTAGES:

- Potent, non-selective germicidal action in high dilution
- Effective against wide range of organisms
- Active in presence of serum
- Low surface tension—penetrating and detergent
- Low toxicity—no mercury, iodine or phenols
- Safe and non-irritating to tissue
- No interference with healing

CEEPRYN

is offered in three forms, all reasonably priced:

- Ceepryn Aqueous Solution (Isotonic) 1:1000 —pints and gallons
- Ceepryn Tincture 1:200—4 ounce, pints and gallons
- Ceepryn Tincture 1:500—4 ounce, pints and gallons

Write for Sample and Descriptive Brochure

Comparative Healing Studies on Control and Ceepryn-Treated Wounds

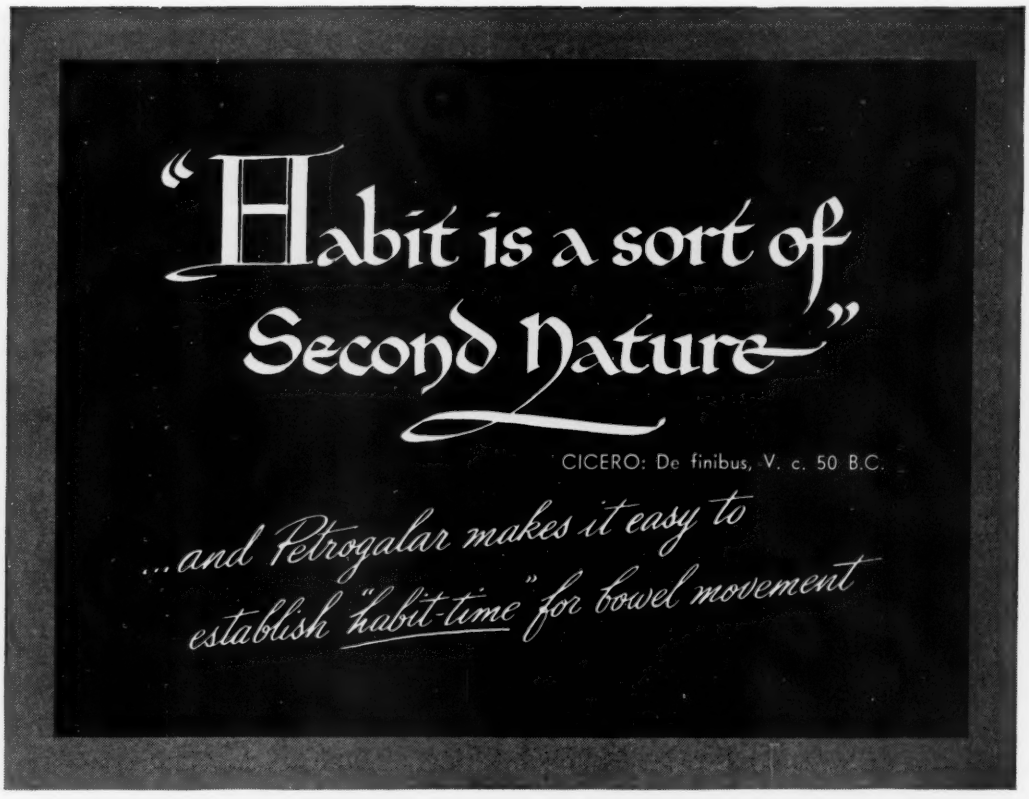
The photographs record the relative healing rate of two wounds produced by removing identical skin areas from the abdomen of a guinea pig. In each picture, "A" is the control area which received no treatment, "B" is the area treated by daily application of Ceepryn Aqueous Solution 1:1000. It is apparent that the daily application of Ceepryn did not in any way retard healing of the wound.

Trade Mark "Ceepryn"
Reg. U. S. Pat. Off.

MERRELL

115th Year

THE WM. S. MERRELL COMPANY · CINCINNATI, U. S. A.


"Habit is a sort of Second Nature"
CICERO: De finibus, V. c. 50 B.C.
...and Petrogalar makes it easy to establish "habit-time" for bowel movement

One of the many reasons physicians like Petrogalar is that it helps to make "Habit Time" second nature with patients.

An *aqueous* suspension of mineral oil, Petrogalar brings effective, yet gentle relief. How? By adding unabsorbable fluid in the colon, Petrogalar brings about comfortable elimination with no straining . . . no discomfort. Furthermore, Petrogalar supplies moisture . . . retains moisture . . . counteracts excessive dehydration.

Miscibility and even dissemination are assured by the fine division of suspended oil globules.

Petrogalar is also pleasant to take. It may be thinned with water, milk or fruit juices.

Five types offer a choice in treating a wide range of conditions.

Try Petrogalar on your next group of patients.

*Reg. U. S. Pat. Off. Petrogalar is an aqueous suspension of pure mineral oil. Each 100 cc. of which contains 65 cc. pure mineral oil suspended in a flavored aqueous gel.

Supplied in 5 Types

Petrogalar Laboratories, Inc.
Chicago, Illinois

Petrogalar*
Promotes "Habit-Time" of Bowel Movement

A Table of Valuable Points for Allantomide*

(GREASELESS, HYDROPHILIC BASE)

THE PRODUCT WITH 10 POINTS	FOR THE TREATMENT OF INFECTIONS, WOUNDS, BURNS AND ULCERS
POINT 1	Helps control and prevent infection or reinfection in wounds; useful in First Aid.
POINT 2	Penetrates readily to infected area where the bacteria can be inhibited by the sulfanilamide.
POINT 3	Allantoin chemically debrides necrotic tissue.
POINT 4	Allantoin stimulates cell growth.
POINT 5	Ease of application eliminates damage to delicate tissue.
POINT 6	Absence of caking obviates the need of frequent redressing.
POINT 7	Alleviates pain by exclusion of air from denuded surfaces, and decreases loss of body fluids.
POINT 8	Provides a semi-fluid covering over wound or burn, allowing uninhibited motion.
POINT 9	Rapid rate of healing minimizes scars and contractures.
POINT 10	An elegant pharmaceutical compatible with the body fluids; no staining of tissues or clothing.

*Reg. U.S. Pat. Off.

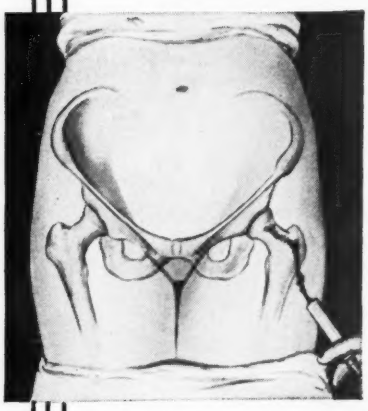
● Allantomide* is a combination of allantoin 2% with sulfanilamide 10% in a greaseless, hydrophilic base. It combines the latest scientific knowledge for the control of infection and stimulation of tissue growth. Available in one ounce, four ounce, one and five pound jars. Write The National Drug Company, Dept. B, Philadelphia, Pa. for information and a clinical sample.

National Drug Company

BIOLOGICALS, BIOCHEMICALS, PHARMACEUTICALS FOR THE MEDICAL PROFESSION

TECHNIC OF LIPIODOL INSTILLATION

VISUALIZATION OF *Sinus and Fistula Tracts*



THE instillation of Lipiodol—iodized poppyseed oil containing 40 per cent iodine in chemical combination—into sinus and fistula tracts provides an accurate means of outlining the extent, nature, and tortuosity of these cavities. Lipiodol (warmed to body temperature) is introduced directly into the external opening by means of a drainage tube if present, or an acorn tip attached to the syringe. After the injection the opening of the tract is closed with adhesive tape in order to prevent escape of the oil while roentgenograms are being taken.

THE above procedure is applicable in the roentgen exploration of virtually any sinus or fistula tract. Fistula-in-ano, empyema cavities, persistent, draining sinuses, tracts leading into joints, and other soft tissue wounds which appear to be channels and whose distal ends have not been accurately located, are all promptly visualized by the instillation of Lipiodol.

Physicians are invited to request the brochure "The Applicability of Lipiodol in Roentgenography and the Technic of its Use," which describes in detail the many uses of Lipiodol.

ACCEPTED AMERICAN MEDICAL ASSN

E. FOUGERA & CO., INC., *Distributors*
75 Varick Street New York, N. Y.

LIPIODOL (LAFAY)

Lipiodol is supplied in a variety of ampule sizes and in a 20cc. vaccine type vial for economy of use.

Controlling the Time Factor, these

DOUBLE

BONDS

ENHANCE CLINICAL VALUE

Azochloramid
REG. U.S. PAT. OFF.

Brand of
CHLOROAZODIN, U.S.P. XII

ACCEPTED
AMERICAN MEDICAL ASSN.
Council on Pharmacy and Chemistry

Unique properties result from the participation of chlorine in the system of alternating double bonds in Azochloramid. This structure controls its stability, persistent bactericidal action and low tissue toxicity.

Outstanding in importance to the clinician is the resultant reduction in time of healing and hospitalization through elimination of wound infection.

Solution of Azochloramid in Triacetin 1:500
To be used undiluted for preparation of medicated dressings and packings.

Saline Mixture of Azochloramid
Tablets or powder to prepare a 1:3300 aqueous solution for irrigation and continuous wet dressings.

W&T

ARMY E NAVY
BUY BONDS

Literature and samples on request
WALLACE & TIERNAN PRODUCTS, INC.
Belleville, N. J., U. S. A.

Following surgery, when the speed of recovery depends so largely on the food intake, Livitamin offers a valuable adjuvant in therapy. It overcomes the weakness and anemia which so frequently develop postoperatively; by providing an adequate amount of B vitamins it corrects the usually present anorexia and prevents the otherwise resultant nutritional deficiencies. The iron in Livitamin is acceptable to the blood-forming organs and does not lead to gastrointestinal disturbances. Because of its palatable taste Livitamin is readily accepted by the patient.

LIVITAMIN

Each fluidounce of Livitamin presents:

Fresh Liver (as concentrate)	3 oz.
Thiamine Hydrochloride (B_1) (3 mg.)	1000 U.S.P. Units
Riboflavin (B_2 or G)	1.00 mg.
Nicotinic Acid (Niacin)	25.00 mg.
Pyridoxine Hydrochloride (B_6)	0.187 mg.
Pantothenic Acid	2.315 mg.
Filtrate Factor	20 J. L. Units
Iron and Manganese Peptonized	30 gr.

In doses of 2 to 4 teaspoonfuls t. i. d. Livitamin rapidly corrects hemoglobin deficiency. Available in 8-oz. bottles.

THE S. E. MASSENGILL COMPANY

Bristol, Tenn.-Va.

NEW YORK • SAN FRANCISCO • KANSAS CITY SEMCO

MULTIPLE THERAPY FOR MULTIPLE DEFICIENCIES

A logical method of supporting the diet during periods of increased need or restricted vitamin intake is the use of—

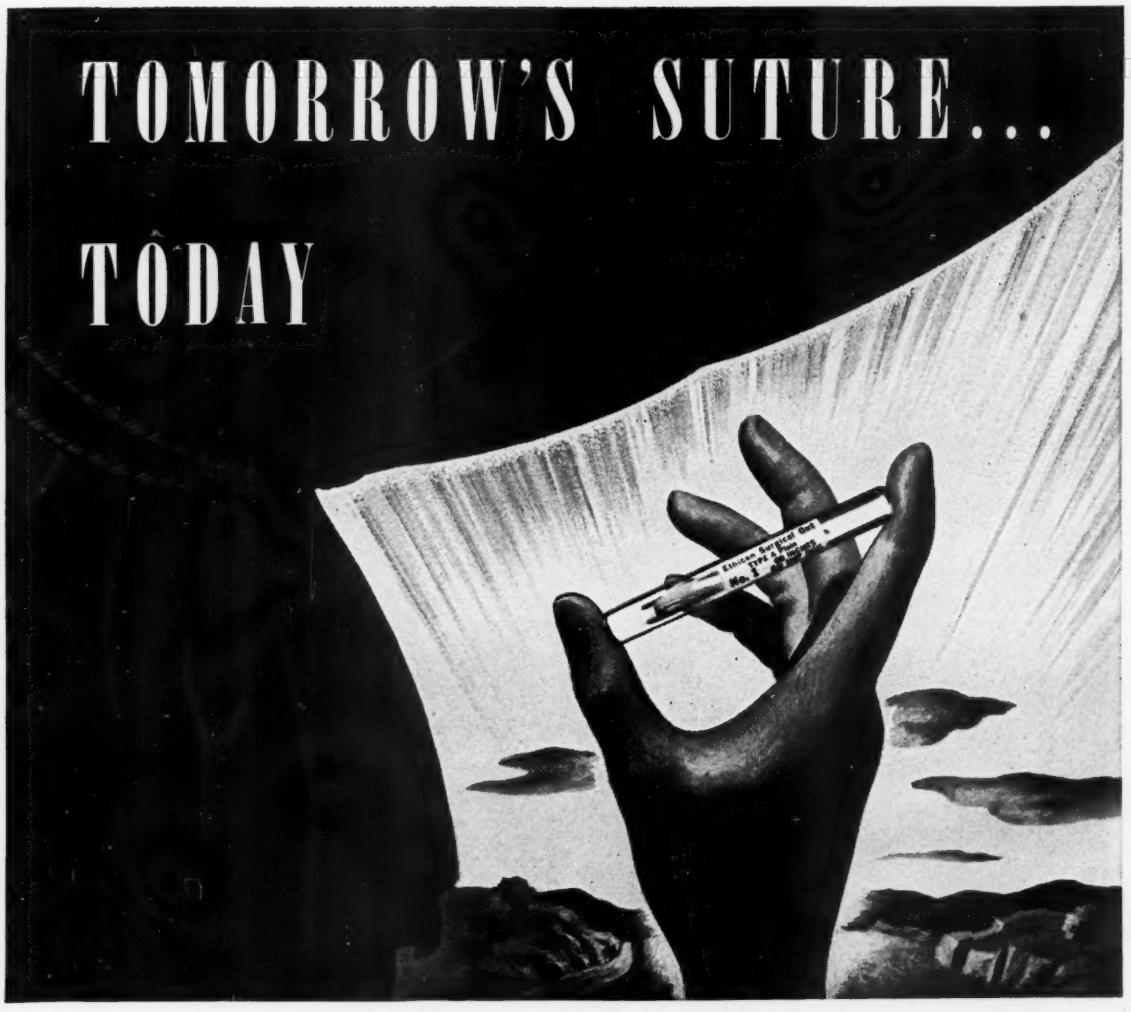
- One Neo Multi-Vi Capsule provides every major vitamin, including all those clinically established, in amounts substantially greater than adult Basic Daily Requirements*—yet does not burden the patient with the cost of supplemental vitamins in amounts beyond his needs and perhaps even beyond his power to assimilate.
- Supplied in bottles of 25, 100, 500 and 5000 capsules.
- Reinforcement with these clinically important vitamin factors is most frequently indicated in—

Surgery	Debilitating diseases
Pregnancy and lactation	Restricted diets
Convalescence	Hypermetabolic states

Ethically promoted—not advertised to the laity. White Laboratories, Inc., Newark, N. J.

**Promulgated in regulations of Food and Drug Administration, 1941*

White's PRESCRIPTION *vitamins*



● Ranking with many important advances in medical science, Johnson & Johnson announces that Ethicon Catgut Sutures now possess new, exclusive, outstanding improvements.

Today the Ethicon label, in the operating room and in your dealer's stocks, is your assurance of these new features to serve your skill:

√ Greater, more uniform tensile strength, made possible by Ethicon's exclusive Tru-Gauging process, which prevents wide gauge variations.

√ Ethicon's exclusive Lock-Knot Finish, which helps to anchor your knots firmly and to hold them securely with minimum knot-tying traction.

√ Resistance to premature absorption, an advantage of Ethicon's Tru-Chromicizing process, by which the strand is uniformly permeated with digestion-resisting chrome.

Anticipating post-war progress in the art of surgery, Ethicon has developed the suture of the future, for your use today.

ETHICON
LOCK KNOT
SUTURES

ETHICON SUTURE DIVISION
OF JOHNSON & JOHNSON
New Brunswick, N. J.

"For leadership...
for quality...
for service."

ARMY E NAVY

Copyright 1943, Johnson & Johnson

The American Journal of Surgery

Copyright, 1943 by The American Journal of Surgery, Inc.

A PRACTICAL JOURNAL BUILT ON MERIT

Fifty-second Year of Continuous Publication

NEW SERIES VOL. LX JUNE, 1943 NUMBER THREE

Editorials

THE USE OF COLOR IN THE OPERATING ROOM*

IN September, 1941, a change was made from white to green in the linen of our operating rooms. The change was premised (1) on the knowledge that eye strain is caused by the glare of the white linen and walls of an operating room, (2) on the knowledge of the satisfactory use of color in other operating rooms, and (3) on the desire to obtain harmony in the general color scheme, as in the construction of the operating rooms of the hospital the wainscoting, ceilings and floors had been finished in green. The change had been contemplated but was deferred for a considerable time due to our lack of knowledge of the actual procedure and with the belief that it would be rather complicated and difficult. Much to our surprise the change was easily made and found to be simple and economical, not requiring the purchase of additional equipment.

Although the use of colored linen is not new, especially in some localities, we have had many inquiries in regard to the actual dyeing procedure from visiting surgeons, physicians, hospital administrators and many others. An advantage not anticipated has been the ease of handling the linen of the operating room, the green color making it less likely to be mixed with contaminated white linen from other parts of the hospital.

It is, therefore, believed that a brief review of the subject together with our method of procedure for dyeing the linen may be of interest to others engaged in hospital work.

On the whole, the literature on the subject is scanty. It seems, however, that in this country Sherman,[1] about thirty-six years ago, in operating upon cleft palates in little children, began to use black cloth around the mouth in place of the ordinary white toweling with the result that the back of the patient's mouth came into the high light, which greatly facilitated the surgery in the back of the oral cavity.

Flagg,[2] in his very excellent paper, discusses the scientific basis for the use of color in the operating room. He points out that in any practical scheme of decorating and furnishing operating rooms there should be included the matter of obtaining maximum amount of ease and comfort to the eyes of the surgeon and other operating room personnel. In this connection, Paul[3] relates the interesting accomplishments and potentialities of color as a medium of aid in the healing of the sick.

According to Flagg,[2] it is obvious that white, the ancient symbol of purity indicating a freedom from moral and physical contamination, was the choice for use in the operating room. The profession and public have regarded not only the "men in white" but the operating room and hospi-

* From the Surgical Service of the U. S. Marine Hospital, Boston, Mass.

tal decorated in white as the criterion of cleanliness and asepsis.

Flagg[2] and others agree that the traditional white walls, white enameled equipment, pure white draperies and toweling used in the operating room neither conserve eyesight nor produce the greatest efficiency on the part of the operating room personnel. Particularly is this true now as surgical intervention has become quite complex and operations within closed cavities are more frequent and are done under stronger lights for the operative field. It is also pointed out that the greater light reflection seriously affects the operator's view of the field of operation, producing greater degree of eye strain and color fatigue.

Eastman[4] states that no matter how strong or perfect one's vision may be, strong artificial light as well as sharp sunlight reflected from glistening white surfaces must harass the eyes. The color fatigue associated with the use of white linen has also been considered as identical with snow blindness. This, of course, is due to the greater degree of pupillary reaction and retinal adaptation which take place when one looks up from the wound to the white draperies and walls and then back into the less illuminated wound.

Since the white operating room is scientifically and physiologically incorrect, it was but natural to have suggestions regarding necessary changes from the white. These suggestions came from various groups of persons, including surgeons, medical men, architects, interior decorators, and stage lighting experts. These persons, according to Flagg,[2] included (1) those interested in the ensemble of the operating room (views aesthetic and psychological) and (2) those interested in the operating room as a laboratory with an interest focused upon the field of operation (views utilitarian or physiological). Also it was logical, since the operating room was merely a setting for the patient and field of operation, that the physiological point of view predominated.

It is further pointed out that the chief difficulties presented by the field of operation are (1) illumination, (2) reflection, and (3) color fatigue. Operations, however, are rarely performed by the exclusive use of daylight. Adequate lighting in the operating room usually is furnished by artificial lights with yellow rays so the problem of supplying daylight is unessential. The problem of reflection is easily solved by using any number of colors in the operating room. Color fatigue, on the other hand, can be satisfactorily prevented only by employing a true complementary color to the operating field. Flagg[2] states that the true complementary color to the operating field has been shown scientifically to be a bluish green which permits maximum illumination. Sherman[1] had previously recommended spinach leaf green as the complementary color to red, blood and tissues.

The successful use of complementary colors is not generally understood. A complementary color always intensifies its opposite, as is demonstrated by the use of the port (red) and starboard (green) lights and the "stop" and "go" traffic signals. Green is by no means the only color used in operating rooms. In many instances blue, red, French gray, ivory, and even combinations of colors, have been used. In the selection of the various colors for the operating room, however, there has not always been scientific consideration of the color of the field or operation or whether the color was complementary in nature.

From a scientific as well as a practical standpoint, therefore, a blue-green or spinach-leaf green is the color of choice for use in the operating room. It should include all draperies, caps, masks and gowns, and, where possible, the furniture, wainscoting, ceilings and floors.

In making the change from white to green, the actual dyeing of the white linen was done in the station laundry. The dye used was "Erie Green G. Y.," which was procured at a cost of sixty-three cents a pound.

The actual procedure of dyeing is as follows: Fifty pounds of white, clean, dry

linen is placed in the washing machine and thoroughly soaked in sufficient boiling water to float the material. Two and one-half ounces (three tablespoonsful) of dye are dissolved in two gallons of boiling water, which is slowly added to the water and material in the machine, which is running at slow speed. This is allowed to run for about five minutes, after which four pounds of common table salt are added. The linen is then brought to a boil and the boiling is continued for thirty minutes. The linen is then taken out and rinsed two or three times to remove the excess dye, after which it is dried or mangled in the usual manner.

After ten to twelve launderings subsequent dyeings in weaker solutions may be necessary in order to maintain the particular shade of color.

REFERENCES

1. SHERMAN, HARRY M. The green operating room at St. Luke's Hospital. *California State J. Med.*, 12: 181–183, 1914.
2. FLAGG, PALUEL J. A scientific basis for the use of color in the operating room. *Mod. Hosp.*, 22: 555–559, 1924.
3. PAUL, M. RAE. How color affects the mental attitude and physical condition of patients. *Mod. Hosp.*, 22: 260–265, 1924.
4. EASTMAN, J. R. Tinted operating rooms. *J. Indiana M. A.*, 7: 366, 1914.
5. CUTTINGS, JAMES A. The reaction of the pupil to colored light. *J. Nerv. & Ment. Dis.*, 46: 246–250, 1917.
6. LUDLOW, WILLIAM O. Color in the modern hospital. *Mod. Hosp.*, 16: 511–513, 1921.

RICHEY L. WAUGH, M.D. AND
ESTHER M. WELCH, R.N.

A NEGLECTED POINT IN BURN THERAPY

NEARLY every surgeon and certainly every medical officer is "burn conscious." The tremendous interest in burns which preceded our entry into the war has been accelerated since and has centered to a large extent on the problem of plasma loss and plasma replacement and to a lesser extent on water balance.

One very important way of meeting these problems has been badly neglected or if not neglected certainly not stressed enough. It is simply the giving of water and liquid food by mouth—the most natural, the easiest, the physiologic way—the way which in the long run must be depended upon anyhow if the patient is to get well.

The whole crux of the situation is whether or not the burned individual can retain things given orally and retaining them whether he can utilize them.

Vomiting has not been an outstanding symptom in the cases of burns I have seen nor is it listed as common in articles covering large numbers of cases. Granted that in some instances vomiting is marked, by the end of twenty-four to forty-eight hours it has usually ceased and the oral route is available while the case is still an early one and probably not yet out of "burn shock."

It may be argued that due to mucous membrane edema or for other causes, metabolism may be so interfered with that the body cannot utilize fluid or food which has reached the gastrointestinal tract. Is not this an assumption rather than a proved fact? But if it is true in the freshly burned patient, it is only temporarily so. The body should have a supply of the needed raw materials on hand for that very first moment when it does regain its ability to metabolize material from the gastrointestinal tract which while somewhat reduced at first is never entirely lost. At least this ability has not been given a fair chance to demonstrate itself.

As far as water balance goes, if we have a patient who can drink and retain water it is common sense to give him enough and let his regulatory mechanisms guide the taking up of what is needed, when it is needed and when the body is able to take it up. Sodium chloride and glucose may be added to the water if desired. We are often so busy giving patients intravenous solutions, carefully balanced against the plasma replacement dosage, that we fail to provide them with a drink of water. At all events the getting of fluid into the burned patient's

stomach is not pushed with the same meticulous planning and persistent execution as is intravenous therapy.

Plasma infusion is ideal and life saving in the emergency in which it is obvious that the body is not able adequately to call on its own protein reserves. But how long are the foods from which the body could replace and supplement its own lost and fixed protein and plasma withheld and emergency measures depended upon entirely? If, as has been shown by clinical observation plasma, even that added by vein, continues to leak into the body tissue or out of the burned surface for forty or more hours, why not supplement the temporary administration of plasma by a liquid diet high in protein, of measured amounts and administered at planned intervals? In an unconscious patient a tube could be used. "Casec" milk shakes such as are used by Ravdin in his preoperative preparation of patients with liver damage would be one convenient way, amino acids as used by Robert Elman another. Vitamins, especially vitamin c, are indicated, first by injection, but as soon as possible included in the oral liquids.

This discussion is in no way directed against the use of plasma or saline and glucose intravenously in the treatment of burns. It is directed against the complete reliance upon them to the neglect of a simple, ready and effective means of therapy.

Major Edward F. McLaughlin, m.c.

FOR THOSE IN SERVICE

An interesting non-commercial contribution in behalf of medical officers in the services of our Armed Forces is the pocket size publication called *Medical Journal Abstracts*. Prepared by the library staff of E. R. Squibb & Sons, it is distributed gratis to each station, camp, hospital or post in sufficient quantity to supply every physician located therein with a copy. A thin, bible paper edition is prepared for distribution overseas.

Medical officers wherever located will find this publication of much value in keeping abreast of advances in clinical medicine.

Original Articles

SURGICAL OPERATIONS WITH THE NAVY MEDICAL CORPS IN THE SOUTH PACIFIC*

LIEUT. COMDR. W. M. JOHNSTON, M.C.-V(S) U.S.N.R.
SEATTLE, WASHINGTON

OUTSIDE of routine surgical care that any large group of young men require, warfare brings the surgical treatment of our armed forces under two main headings: (1) the treatment of burns, and (2) the treatment of combat wounds.

What may not be known by the average layman, is that the U. S. Marine Corps is under the Medical supervision of the U. S. Navy. Therefore, all Marine casualties are the responsibility of the Navy Medical Corps as well as the casualties of the Navy Department itself.

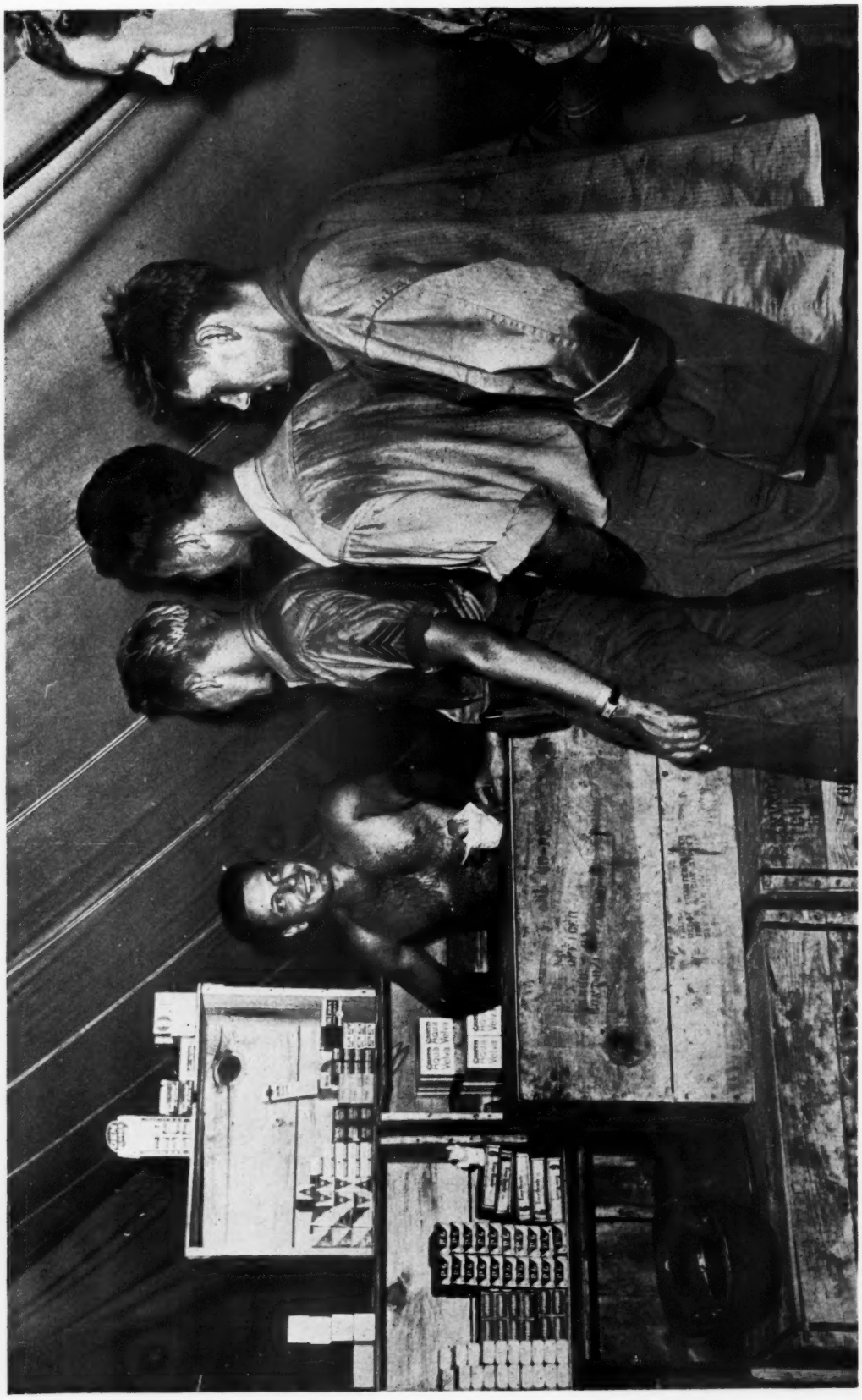
As a Navy Medical Officer, I had the fortunate, or unfortunate, experience to be attached to duty in the South Pacific in the summer and autumn of 1942 and was present in our first offensive against the enemy in that region, or in fact, our first offensive in this war in any region. It so happened that I was fairly severely wounded in action against that enemy. Before that circumstance, I had an opportunity to care for and observe some of our casualties, and afterward to be under care myself in our own base hospital and eventually as a patient in the same Naval Hospital in the United States, where I had previously been on duty before going to sea. Under the care of this same Medical Corps of which I am proud to be a member, I made an excellent recovery and returned to active duty in February, 1943.

It is a rare opportunity and education as a surgeon to have the privilege of attending battle casualties for a time and then to be under care personally as one of these casualties by your fellow officers. You observe and experience all these things from both points of view and it is far more enlightening than reading a dozen volumes about it.

My report will be from the rather broad experience of action on land, action at sea, including a night alone in a life jacket while wounded, as a member of the surgical staff and a patient in an advanced Naval Base Hospital, as a patient on a hospital ship, and finally as a patient and member of the staff of several Naval Hospitals in the United States.

Reserve Medical Officers in our first year of foreign duty were almost exclusively the group of specialists who had been members of the Medical Specialists Units which had been organized by the Navy throughout the United States for several years. Due to the ability of these highly trained men and their modern and efficient methods, to the use of the sulfa drugs, to the abolition of worn-out methods, to the fact of prompt attention and careful follow-up, both the mortality and morbidity of the battle casualties have been kept far below that of any other war of all history and below that which we ever dreamed possible. The American people can be sure that their sons will have the best medical and surgical care that is known in the world today.

*The opinions and views set forth in this article are those of the author, and are not necessarily to be considered as reflecting the policies of the Navy Department.



Corner Drug Store—Guadalcanal (U. S. M. C.)

Most of the wounds occurred in young, healthy males and the advantage of that kind of material is well known to any Medical Officer of any experience. In our opinion, one of the mistakes of the Navy Department after Pearl Harbor, was lowering the restrictions and physical requirements for enlistment. This was not done at the request of the Medical Department as any Medical Officer of experience knew that would be a mistake. The Medical Department has been busy surveying these men out of the service ever since and will continue to do so, at considerable expense to the taxpayers: Unfortunately, one-half of the casualties which returned to the States on the transport with me were not battle casualties, but men who in the language of the service, could not "take it." From my observations, I must say that I do not think the physical requirements or mental qualities of candidates for the Navy should be lowered in any manner. There is no advantage of any kind to be gained thereby, and there are countless disadvantages. We have to remember the drastic action rule of warfare, namely, that a dead man gives much less trouble than an incapacitated one.

I. THE TREATMENT OF BURNS

The subject of burn treatment is of considerable importance in naval warfare, especially in casualties aboard ship. It happened that we had an opportunity to observe many of the casualties from the aeroplane carrier Wasp after she had been sunk by a submarine. It happened that most of the casualties aboard her were burns, resulting from explosion of gasoline on her decks.

There have been numerous publications in the surgical journals in the last few years on the treatment of burns—most of these authors stressing external applications of first one product and then the other. Often in combat in various surroundings you may not have the opportunity to use what is desirable but what you have. In my opinion, in case of severe burns, it is not so much what you use externally that counts but perhaps what you use internally. Your job as a physician is to keep the patient alive, especially during the first twenty-four hours. Again our achor sheet is plasma. Do not be afraid to use too much, but be certain that you use enough.

I will briefly outline the treatment of burns that we suggest in the Navy, but bear in mind that all these ideal treatments may not be available for several hours under actual combat conditions.

When the burn first happens, the first aid treatment should keep the four cardinal principles in mind: (1) To keep the burned area from further contamination; treat it as an open wound; (2) to prevent and combat shock at once, by plasma transfusion as soon as possible; (3) to control pain, which also combats shock; and (4) to minimize fluid loss.

You should then administer 4 gr. of sulfadiazine by mouth which should be in the first aid pouch. Get the morphine to the patients promptly. If the burn is extensive, give them ½ gr. of morphine. Administer the "booster" dose of ½ cc. of tetanus toxoid.

Remove rings from fingers; apply boric acid ointment over the burned surface, if available, otherwise use vaseline. Lay two layers of fine mesh gauze over the ointment, place the first aid dressing gauze over this, then apply a muslin bandage snuggly over all. Finally, if an extremity is burned, splint it. When the patient reaches the Base Hospital, the real treatment starts.

To overcome shock, prompt administration of plasma is commenced. Quantities up to 12 units may be required in the first twenty-four hours in severe cases. When the patient is in critical condition, the first plasma should be given rapidly, the first 500 cc. in five minutes.

For treating the burn itself, the Medical Officer and all his assistants should be masked, and the burned area treated as an open wound. The first aid dressings are removed and the burned area cleansed. If covered with oil, it is removed by a deter-

gent, supplied by Naval Medical Supply Depot; in an emergency, sterile lard or mineral oil may be used. Afterward, the area and the surrounding skin are cleansed carefully with white soap, brushes are not used, yet the area is carefully cleansed with the soap.

Gowns are then changed and careful débridement carried out. All blisters and loose shreds of skin or tissue are removed with sterile instruments. Deeper tissue that may appear to be damaged should not be débrided at once, as it may be done secondarily in a few days if necessary. Remember at all times to treat the burn with the same respect as you would an open wound.

After cleansing and débriding the area, it is dressed by applying a fine mesh sterile gauze impregnated with boric acid ointment or vaseline. A smooth thick layer of sterile gauze is applied over this and these dressings are held in place by a smooth, evenly applied bandage. Firm pressure is important as it prevents serum loss. Finally, if an extremity is involved, a splint is applied. Unless complications develop this dressing is not disturbed for about ten days; then you will find that all first and second degree burns will be largely healed. Areas of whole skin thickness loss, that is, third degree burns, should be prepared for grafting by excision of all dead tissue and further preparation if suppuration is present, but skin grafting should be done at the earliest possible moment when there is a full thickness skin loss.

During this time, do not forget the four cardinal principles: (1) control of pain (2) replacement of fluid loss, by plasma at first, later with glucose and whole blood as anemia develops (3) the prevention and combatting of shock as promptly as possible, and (4) the treatment of all burns as open wounds.

II. COMBAT WOUNDS

As we stated, outside of routine surgical conditions and burns, all surgical care during warfare is either due to or the complications of wounds of various types received in combat. In discussion of these wounds I do not desire to take them up section by section, but merely to state a few observations made from treating these cases and from the personal experience of receiving a few of these wounds myself. This latter you possibly will not read about in text books.

Two forces are at play if a missile is lodged in the organism, namely, the energy of the missile and secondly the resistance of the body. The energy of a missile equals half its mass times the square of its velocity. Thus we see that the velocity is of much greater importance than the mass. For example, the initial velocity of hand grenade splinters may be as high as 2,000 meters per second and splinters weighing only 1 Gm. have force enough at this speed to fracture a femur. The less the velocity, the more likely that a missile will remain in the body. Air resistance and gravitation, especially if a missile is directed upward as in mountainous territory or in airplanes has its effects, as the velocity is reduced. According to this mathematical calculation, the greater the mass of a missile, the greater is its penetrating power provided the velocity remains the same. For this reason someone has said large missiles are less likely to remain in the body than small ones. True, but unfortunately the human body is a poor resistance against the missile of modern warfare. I have seen eight-inch shells go through a destroyer like through a parchment box. I have seen them cut off coconut trees like toothpicks. I saw three bombs from planes four miles high, hit a destroyer simultaneously and sink it in exactly two minutes. Naturally, when this type of missile hits a human body there just is no body. So that the wounded we treat are the survivors or the ones who were struck by comparatively small missiles, shrapnel and other fragments and rifle bullets. Hence they take various and divers courses when they strike the human body, both due to their direction and velocity and to the resistance of that part

of the human body they strike, such as bone.

Also the part of the body these strike makes a great deal of difference in the pain and reaction of the man in combat. I remember that I received several shrapnel wounds that were flesh wounds and although they made quite large openings, I did not feel any of them when they were made. Yet, when hit in the water over the lumbar area with a large piece of spent shell which did not break the skin, it seemed as though someone had broken my back.

I remember treating a marine who had been struck in the head of the right humerus by a rifle bullet which knocked him down and turned him completely over. He said he thought someone had hit him in the shoulder with a baseball bat.

At the Base Hospital, missile or foreign bodies are removed if they are immediately accessible, if they are the cause of an infection, if they intrude upon or endanger any important structure as a nerve or large blood vessel, or if they are in a joint. Otherwise they are not disturbed. In locating these foreign bodies, *x*-rays taken in the anteroposterior position are a great aid and at times operating directly under the fluroscope may be necessary and also may save much time and blind searching.

Wounds received in action showed an interesting contrast in regard to infection between those patients who were in the water after they had been wounded and those who were on the land. Those that were in the salt water for several hours had much less infection and healed cleaner than those secured on land.

Personally, I had nine separate wounds and spent eight hours in a life jacket in the salt water at Guadalcanal, which is very warm in this tropical area. We did not have a sign of infection in any wound and I saw this happen in dozens of cases and in wounds much more severe than mine. This fact gives us the idea which we carried out, that there is nothing of more value to clean a combat wound than warm saline.

Wounds, except for wounds of the abdomen and perhaps wounds of the face and lips, are better treated without suturing. The best suture material is alloy-steel wire, using the very fine sutures on the face. Even in the case of abdominal wounds with colon perforations we do not believe that the skin and subcutaneous areas should be sutured.

We believe that with the correct and prompt use of the sulfonamides, débridement which was advised so strongly in the latter part of World War I and is still advised in many of our recent publications, can largely be dispensed with, except in definitely destroyed tissue. Otherwise its use, we believe, is destructive and harmful.

Many of the wounds that are treated conservatively can have a secondary closure later, while a case of radial débridement often will require many weeks of plastic surgery and skin grafts, to say nothing of the possible injury to important blood vessels and nerves.

In case the wound caused a compound fracture of the extremity, good results were obtained by treating the wound with sulfathiazole or sulfanilamide, leaving the wound open. Those that were closed became infected and had to be opened later, and immobilized then in plaster for safe transportation. The only disadvantage in this type of treatment was the lack of traction in cases in which it was indicated. But when these cases reached the Base Hospital, they responded well to traction by the Stader splint or other methods of the Orthopedic Medical Officers and the end results as a whole were excellent.

At the first dressing on the battle front as in sea battle, the wounds are simply cleaned with warm saline solution and on the outside with white soap and then are sprayed with sulfathiazole; or the wound has one of the sulfa drugs in the powdered form introduced directly into the wound and a snug dressing applied before his transfer to a Base Hospital or a hospital ship. Naturally, hemorrhage is checked,

and morphine is still the great dependable drug in combat wounds.

In case of shock in the wounded, we do not forget the life saving plasma intravenously or blood transfusion when hemorrhage is present as it often is in these wounds. In severe wounds the old treatment of morphine, heat and fluid, has been changed to morphine, sulfonamides, plasma and whole blood. The "booster dose" of tetanus antitoxin is administered, as is also the prophylactic dose of gas bacillus antitoxin if the Medical Officer thinks it is indicated.

A word about gas bacillus infection and gas gangrene. We find with our modern methods of treatment the evidence of gas bacillus infection is markedly lowered when compared with that of World War I. When it does occur, we find that the conservative treatment of exposing the infected muscles, the use of sterile zinc peroxide, and the use of gas gangrene antiserum will largely replace the old method of radial amputation in these cases.

Immobilization that proved to be of such benefit in the latter part of World War I, is still carried out in all severe wounds of the extremity. It prepares the patient for transportation and saves many lives.

During the offensive last summer, the severely wounded, after these other treatments, were placed in casts or splints and taken by areoplane to the next available hospital with a very low mortality. And in our opinion, the areoplane will be the ambulance of the future and in the present war in the Pacific. It can easily transport the severely wounded for hundreds of miles in a few hours to a comparatively safe hospital, and deliver the patient with a minimum of added trauma. When these wounded are landed at the Base Hospital, they are treated as the individual case indicates. The officers and corpsmen are schooled in all the complications, especially that of secondary hemorrhage and should always be on the lookout for it and ready to handle it promptly.

Lastly, I repeat, in whatever part of the combat you are called upon to serve, do not forget our great aids in case of combat wounds, namely, morphine, sulfonamides, plasma and immobilization. If the question of radial or conservative measures should arise in treating any combat injury, except wounds of the abdomen, use the latter and I am sure your results will continue to be brilliant and gratifying.

INTRA-ABDOMINAL INJURIES*

COSTABILE DI LORENZO, M.D.,
Assistant Surgeon, Harlem Hospital

MILTON ROTHMAN, M.D.
Research Fellow in Surgery, Harlem Hospital

AND

CLARENCE HOWLEY, M.D.
Director of Surgery, Harlem Hospital
NEW YORK, NEW YORK

THIS communication is concerned with the study of 115 patients with intra-abdominal injury treated at Harlem Hospital from January 1, 1938, to December 31, 1941. All cases of stab wound, gunshot wound and nonpenetrating injury of the abdomen, with injury to intra-abdominal viscera or vascular structures, treated during the period of this report, are included in this study. Those cases of penetrating wounds of the abdomen without injury to intra-abdominal structures, as well as those cases of nonpenetrating injuries that were not explored, are excluded from this report.

This study of 115 cases includes seventy-nine with penetrating stab wounds of the abdomen, sixteen with gunshot wounds and twenty-nine with nonpenetrating intra-abdominal injuries. Of the 79 patients with stab wounds treated, sixty-six were males and thirteen females, a proportion of 5 to 1. All were colored, a fact which is not surprising since 90 per cent of the patients at Harlem Hospital are colored. The wounds were inflicted by ice picks in two cases, scissors in one case, and by a fall over a glass top table in another case. In the remaining cases the injuries were produced by knives, often of the switch blade variety. The gunshot wounds were most frequently inflicted by pistols of .32 or .38 caliber. Accurate details of the distance between the firearm and the patient, as well as the relative positions of the victim and the assailant, and consequently of the direction of the bullet, were not available owing to the confusion existing at the time of injury. The nonpenetrating injuries were caused by automobiles in ten cases; in four they resulted from falls, in three from blows or kicks, in two they were produced from sleigh ride injuries, and in one case the cause could not be determined.

In all the cases with penetrating stab wounds of the abdomen, no patient had more than one penetration into the peritoneal cavity. Figure 1 reveals the location of these wounds. A large preponderance in the number of wounds will be noted in the upper third and left half of the abdomen. This is probably due to the fact that the blows were struck by right handed assailants in the majority of instances, and would naturally fall on the left side of the victim's body.

In the gunshot injuries, there were sixteen wounds of entry and ten wounds of exit. In all cases there was only one wound of entry. Figure 2 shows the approximate paths of the bullets obtained by connecting the wound of entry with the wound of exit. Where no wound of exit was present, the path of the bullet was obtained by studying the position of the bullet as noted at operation or on roentgenograms, in relation to the wound of entry.

In the nonpenetrating injuries, the injured viscera were either the solid organs or hollow viscera close to their points of fixation.

The average period that elapsed from the time of injury to the time of admission to the hospital was seventy minutes for the entire group. The time was essentially the same for the group that died and the group

* From the Surgical Department at Harlem Hospital.

that survived. The period between the time of admission and the time of operation was 180 minutes. This interval was necessarily variable depending in many instances on the period required for the observation of the patient, for the preparation of the patient for operation and for the treatment of shock. These figures do not include four cases in which patients refused operation for twelve to eighteen hours. The average time elapsing before operation for the group that survived was 160 minutes and for the group that died was 190 minutes. Practically all patients were brought to the hospital by ambulance; a few were brought in by taxicabs.

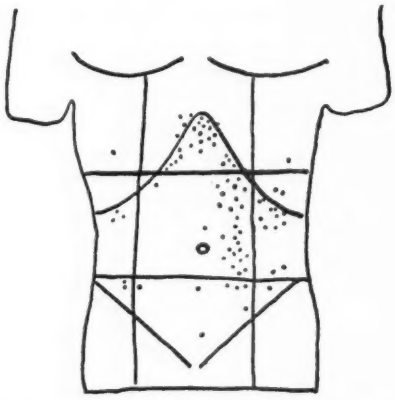


Fig. 1. Location of stab wounds.

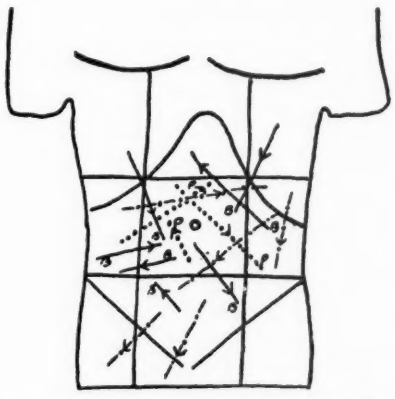


Fig. 2. Approximate path of bullets. P . . . signifies the bullets that exited posteriorly; B shows the location of bullets found in the abdomen.

Table I
PATHOLOGY OF STAB WOUNDS

Organ	Combined Injuries		Pure Injuries	
	No.	Per Cent	No.	Per Cent
Liver	29	36	22	27
Eviscerations	23	28		
Vascular injuries	19	24	1	
Stomach	15	18	8	10
Small intestine	15	18	5	6
Large intestine	12	15	7	11
Gallbladder	3	..	1	
Kidney	1			
Bladder	1	..	1	
Pancreas	1			
Pneumothorax	9	11		
Associated spillage	53	67		

The most frequent finding in penetrating stab wounds of the abdomen is injury to the liver. This was found in twenty-nine, or 36 per cent of the stab wounds. (Table I.) In twenty-two of these the laceration of the liver was the only intra-abdominal injury present.

Eviscerations occurred in 28 per cent of the cases. Next in frequency were the vascular injuries which include injuries to the greater and lesser omentum, major blood vessels and retroperitoneal hematoma. Injuries to the stomach, small intestine, and large intestine followed in the order named. Intraperitoneal spillage of blood, gastrointestinal content, bile or urine occurred in fifty-three or 67 per cent of the cases. There was an associated pneumothorax in eleven cases, these cases representing combined intrathoracic and intra-abdominal injury.

In gunshot wounds of the abdomen the most frequent injury found was to the small intestine. (Table II.) Injuries to the large intestine, vascular structures, liver and stomach followed in the order named. Multiple injuries were present in thirteen out of fifteen cases. In one case the injuries could not be ascertained as the patient died before he could be operated upon. Pneumothorax was found in three cases, denoting combined intrathoracic and intra-abdominal injury. An intraperitoneal spillage of

blood occurred in nine or 60 per cent of the cases.

Table II
GUNSHOT INJURIES

Organ	No.	Per Cent
Small intestine	9	56
Large intestine	7	43
Vascular injuries	7	43
Liver	3	19
Stomach	2	12
Spleen	1	
Kidney	1	
Bladder	1	
Eviscerated omentum	1	19
Pneumothorax	3	
Spillage of blood	9	60

In twenty cases of nonpenetrating intra-abdominal injury, the spleen was involved in nine, the small intestine in six, the liver in four, and the urinary bladder in one. A gross intraperitoneal spillage of blood was present in thirteen or 65 per cent of the cases. In one case there was a complicating pneumothorax.

Intra-abdominal injury results in injury to the hollow viscera, solid organs and vascular structures. This in turn may result in the intraperitoneal spillage of blood, gastrointestinal contents, bile or urine. This spillage into the peritoneal cavity may give rise to the signs and symptoms encountered in intra-abdominal injury. However, perforation of the gastrointestinal tract without gross spillage may also be associated with signs and symptoms pointing to the abdomen. Vomiting, abdominal pain, tenderness, rigidity, rebound tenderness, distention, and traumatic evisceration may be present with or without the symptoms and signs of an associated shock. In passing it may be mentioned that evisceration at the time of injury is a pathognomonic sign of a penetrating injury of the abdomen. The local signs of intra-abdominal injury may be masked when the patient is in shock or under the influence of alcohol.

Whenever gross intraperitoneal spill was present, abdominal signs and symptoms were almost invariably present. In only four of the cases with stab wounds of the abdomen out of the fifty-three cases with intraperitoneal spillage were abdominal signs and symptoms lacking. (Table III.) Two of these patients were in shock on admission. Of the remaining two patients without signs or symptoms, one had laceration of the liver, and the other a wound of the gallbladder.

Table III
RELATION OF SYMPTOMS AND SIGNS TO GROSS INTRAPERITONEAL SPILL

Pathology	Total	Symptoms	Evisceration	Asymptomatic	Asymptomatic with shock
Blood spillage	46	37	7	2	1
Gastric spillage	6	5	0	1	1
Bile spillage	1	0	0	1	0

There were forty-four patients with perforation of the gastrointestinal tract due to stab wounds. Fifteen had perforations of the stomach, fifteen of the small intestine, and fourteen of the large intestine. (Table IV.) All had symptoms and signs pointing to the abdomen except one case with a perforation of the stomach, and three cases with perforations of the colon. Two of these patients, one with a perforation of the stomach, and one with a perforation of the colon entered the hospital in shock. In summary, of the seventy-nine patients

Table IV

Perforations	Total	Symptoms	Evisceration	Asymptomatic	Asymptomatic with Shock
Stomach	15	14	0	1	1
Small intestine	15	13	2	0	0
Large intestine	14	9	2	3	1

with stab wounds treated, all had either gross intra-abdominal spillage, or perforation of the gastrointestinal tract. Only eight of these patients had no symptoms or signs pointing to the abdomen, and four of these were in shock on admission.

are to be considered of value only if positive. Roentgenograms are of value in locating bullets, and also in evaluating associated injuries of the chest, resulting in pneumothorax and hemopneumothorax. In cases of suspected bladder injury,

TABLE V

RELATION OF PATHOLOGY TO MORTALITY

Organs	Stab Wounds Combined			Stab Wounds Pure			Gunshot Wounds			Nonpenetrating Wounds		
	No.	Died	Per Cent	No.	Died	Per Cent	No.	Died	Per Cent	No.	Died	Per Cent
Liver	29	8	27	22	7	32	3	1	33	4	1	25
Evisceration	23	4	17	..	..	..	1	0				
Vascular injury	19	5	26	..	..	..	7	5	71			
Stomach	15	5	33	8	2	25	2	2				
Small intestine	15	7	46	5	2	40	9	7	78	5	3	60
Large intestine	12	1	8	9	1	11	7	5	71			
Gallbladder	3	1	33	1	0	..	1	1				
Urinary bladder	1	0	..	1	0	..	..	..	..	1	0	
Kidney	1	0	..	1	1							
Pancreas	1	0										
Spleen	..	..	..	..	..	..	1	1	..	9	4	66
Blood spillage	52	18	35	..	..	..	13	10	77	13	6	46
Retroperitoneal hematoma	5	2	40	..	..	..	3	2	66	2	1	50
Shock	30	12	40									
Without shock	49	8	16									

There were sixteen gunshot wounds of the abdomen. One of these patients died before he could be operated upon. Thirteen of the remaining fifteen had multiple intra-abdominal injuries. All had signs and symptoms pointing to the abdomen with the exception of two patients. One of these was in severe shock on admission.

All of the twenty patients with nonpenetrating intra-abdominal injury had signs and symptoms pointing to abdominal injury prior to operation, probably because these patients would not be operated upon the absence of localizing symptoms.

Pneumoperitoneum, as demonstrated by *x*-ray, and the diagnostic aspiration of blood on puncture of the abdomen are valuable corroborative evidence of intra-abdominal injury when present; but these are so often absent in the presence of real intra-abdominal injury that both measures

catheterization of the bladder and the injection of a radio-opaque substance may be used to delineate the contour of the bladder.

Twenty of the seventy-nine patients with penetrating stab wounds of the abdomen treated, twelve of the sixteen gunshot wounds, and nine of the twenty nonpenetrating intra-abdominal injuries died, giving a mortality rate of 25, 75 and 45 per cent, respectively, for the three groups.

It is interesting to study the relationship between the organ injured and the mortality rate. (Table v.) The mortality rate in stab wounds for cases in which only one organ was injured is compared with the mortality rate in those cases in which the organ injured was associated with other intra-abdominal injuries. In general, the mortality rates for the pure and combined

injuries ran essentially parallel. The stomach and small intestine injuries in both groups had higher mortality rates than injuries of the large intestine, a fact which is rather startling. The mortality rate for injuries of the liver was about 30 per cent in both groups. The traumatic eviscerations revealed the relatively low mortality rate of 17 per cent. Forty per cent of the patients who entered the hospital in shock died as compared to a mortality of only 16 per cent for those admitted without shock. It is interesting to note that the average intraperitoneal spillage of blood was 600 cc. in the patients who died and 350 cc. in the surviving group.

In gunshot wounds of the abdomen, the mortality rate was so high, and the presence of multiple injuries so numerous, that no worthwhile deductions bearing on the prognosis from a statistical study of the injuries to the different organs could be reached.

In the nonpenetrating intra-abdominal injuries, injuries of the spleen showed a mortality rate of 66 per cent, the small intestine 60 per cent, and the liver 25 per cent.

The average stay in the hospital for the group that survived was 19.2 days; and for the group that died was 4 days. The average hospital stay was 18.9 days for the patients with stab wounds who survived, 18 days for the surviving gunshot wounds, and 24 days for the surviving nonpenetrating injuries.

All the patients with intra-abdominal injuries were given morphine on admission to the hospital. The patients with penetrating stab wounds also received 1,500 units of tetanus antitoxin, and those with gunshot wounds 3,000 units. If the patient was unable to void, he was catheterized in order to evaluate injury to the urinary passages, and to assure an empty bladder at operation. The pulse, blood pressure, and respirations were noted every hour to detect the onset of shock, concealed hemorrhage, or tension pneumothorax. The blood was routinely typed. If the patient was in shock on admission, he was placed in Trendelenburg position, and administered hot blankets and hot water bottles, and an infusion of 5 per cent glucose in normal saline was started. In the cases admitted in 1941, cortate was also injected. If blood was available and the patient's condition warranted it, he was given a transfusion. The patient was then prepared for operation. All patients with intra-abdominal injuries are operated upon as soon as they can be put in condition for operation, and at the earliest possible moment.

The delay in the operation enforced by the adequate preoperative treatment of shock, need not, if not unduly prolonged, materially increase the risk of infection now that the intraperitoneal use of sulfonamides is quite generally practiced. There were nine patients who were operated upon five or more hours after admission because of their refusal to consent to operation. Three died and six recovered, a mortality rate of 33⅓ per cent which is not in excess of the prevailing mortality rate, since one of these three patients operated upon twelve hours after admission for a perforation of the jejunum died of peritonitis. The other two died of shock and hemorrhage.

If the patient showed signs of respiratory distress, a pneumothorax reading was taken, and underwater drainage instituted if necessary. In cases of associated chest and abdominal injuries, the underwater drainage set-up was always kept ready for instant use in case dyspnea developed.

Open cone ether was used as the anesthetic of choice in the majority of the 115 cases with gas, oxygen, and ether next in order of frequency. Spinal anesthesia was used in only four cases, since the frequent presence of shock and intra-abdominal hemorrhage constituted a decided contraindication to its use. Furthermore it has the tendency to increase intestinal peristalsis and would, therefore, have the tendency to increase the gastrointestinal tract. Local 1 per cent novocaine anesthesia was used in three cases, in which there was a complicating pulmonary tuberculosis.

In all cases of penetrating intra-abdominal injury it is desirable to visualize the zone of injury. This is relatively easy in the stab wounds, and more difficult in the gunshot wounds. In the latter, the bullet must be located by roentgenograms and its location studied in relation to the wound of entry. The wound of entry may be distinguished from the wound of exit by the fact that it is smaller and is associated with an area of abrasion and contusion. The wound of exit is keyhole in shape and larger in size. A bullet which has penetrated any part of the peritoneal cavity in any direction will almost certainly pierce the gastrointestinal tract. The only exception is that of an anterioposterior bullet path across the top of the right subdiaphragmatic space.

A crushing or blunt force may injure the intra-abdominal viscera without leaving any marks in the abdominal wall.

The incision used is the one which most adequately exposes the zone of injury. If there is only one abdominal wound, the incision should either include or be placed near this wound. The incision is carried down to the peritoneum, which is entered in all gunshot wounds, and in all nonpenetrating injuries. In stab wounds, if penetration of the peritoneum is not readily found, peel away the peritoneum and look for the perforation in the peritoneum or for signs of intraperitoneal hemorrhage. If no signs of penetration are found, the abdominal wall is closed and a Penrose drain inserted down to the peritoneum. If an opening in the peritoneum is noted, the peritoneal cavity is opened and a thorough exploration carried out. In the above series, a paracostal incision was used seven times, a transverse incision once, and in another case the abdomen was explored through the enlarged abdominal wound. The incision used in the remaining cases was a rectus muscle splitting incision placed over the zone of injury. The incisions must be adequate so as to favor wide exposure and thorough and rapid exploration.

Once the abdomen is opened, the aim of the surgeon must be to stop hemorrhage, and to stop any further spillage from rupture or penetration of a hollow viscus. If hemorrhage is a feature of the operative findings, the blood should be suctioned off, and lap pads should be used freely to soak it up, so as to visualize the source of bleeding. The blood tends to accumulate in the lumbar gutters, from which it gravitates to the pelvis. The pelvis must be aspirated dry, otherwise the blood tends to well up into the lumbar gutters and obscure the source of the bleeding. If the bleeding point is not immediately apparent, proceed systematically to the examination of all the solid organs that could possibly come within the zone of injury. Palpation may be sufficient, but it is better to visualize the organ if possible. The search for the bleeding point may then be continued by the systematic examination of the gastrointestinal tract from beginning to end, also noting any existing perforation of the bowel in the meanwhile. Any bleeding noted in the omentum, mesentery, or major blood vessels must be controlled. If any portion of the intestine is separated from its blood supply, it must be resected. Where hemorrhage is not a feature of the operative findings, a search must nevertheless be made for perforations of the gastrointestinal tract from beginning to end. A hint as to the organ injured is often found as soon as the abdomen is opened. A fecal odor, or the actual presence of feces will direct attention to the large intestine or rectum; bile will direct attention to the gallbladder or to the upper gastrointestinal tract, thin serous fluid to perforations of the stomach and small intestine, and urine to the bladder.

The abdomen is usually closed in layers; in only two of our cases was closure effected by through-and-through sutures. The wounds in the peritoneum are usually closed from within the abdomen, and a Penrose drain or a wick of gauze placed in the wound of entry or exit.

Intraperitoneal drains were used in sixty or more than half of our cases. They were used whenever the peritoneum had been badly contaminated by gastrointestinal spill, or when oozing from injury to the solid organs, or from vascular injury might

be expected to continue postoperatively. Of the sixty drained, thirty-five were drained because of spillage from perforations of the gastrointestinal tract, twenty were drained because of the possibility of continued oozing from injury to solid organs or from vascular injuries; and five were drained because of contamination of the peritoneal cavity from traumatic evisceration of intestine and omentum. The tendency lately has been to drain less and less and to rely on a painstaking toilet of the peritoneum, meticulous hemostasis and the intraperitoneal use of sulfonamides. Ten to 12 Gm. of sulfanilamide or sulfathiazole were used in our cases.

It may now be worth while to consider special points in the treatment of each organ. There were twenty-nine stab wounds, three gunshot wounds and four nonpenetrating injuries of the liver, in all thirty-six wounds of the liver, with a mortality of 27, 33, and 25 per cent for each group, respectively, and of 27 per cent for the group as a whole. (Table v.) Twenty of these injured livers were treated by suture with a mortality of 20 per cent, and sixteen were treated by packing with a mortality of 37 per cent. The greater mortality for the group treated by packing may be due to the fact that this treatment was reserved for the more severe injuries of the liver. There were in all ten deaths in patients with injury of the liver; four died from shock, four from pneumonia, one from peritonitis, and one from liver death.

There were eleven lacerations of the spleen from all causes. All were treated by splenectomy, six recovered, and five died, giving a mortality rate of 45 per cent for the group. All of the five that died, did so from shock and hemorrhage. Two died on the operating table, one of these dying from a rupture of the diaphragm incident to the removal of the spleen.

There were two lacerations of the kidney in the series, one a patient with a gunshot wound treated by gauze tamponade who died from peritonitis; and the other a patient with a stab wound of the kidney and pancreas who recovered. The kidney was sutured, and the pancreas drained in this case. In injuries of the kidney, the peritoneum overlying the kidney must be sutured, if penetrated, to prevent leakage of urine into the peritoneal cavity. If the kidney wound is packed, the gauze packing may be brought out through a lumbar wound made by the surgeon, or through a convenient wound of entry or of exit. Nephrectomy is only indicated in extensive damage to the hilum of the kidney or with uncontrollable hemorrhage.

The group of vascular injuries included bleeding from the lesser, and greater omentum, mesentery, major blood vessels, and retroperitoneal hematoma. There were nineteen cases in which the vascular injury was due to stab wound with five deaths, and seven cases in which the injury was due to gunshot with five deaths, giving a mortality of 26 and 71 per cent for the two groups, respectively. Of the ten patients who died, five died from shock, four from peritonitis, and one from pneumonia. In this group of vascular injuries were ten cases of retroperitoneal hematoma, with five deaths, a mortality of 50 per cent for the group. Of the five who died, four died from shock, and one from peritonitis. It may be noted in passing that it is unwise to explore these retroperitoneal hematomas unless they expand rapidly in size, as to do so may release the tamponade and result in violent and uncontrollable hemorrhage with quick exitus of the patient.

There were four gallbladder injuries with two deaths. Both of the patients who died had multiple injuries of the liver, stomach and small intestine, and death was in all probability due to the associated injuries rather than to the gallbladder injury. Of the two patients with gallbladder injuries who recovered, one had a nonpenetrating wound of the serosa which was sutured, and in the other case the gallbladder was drained through the stab wound. The patients who died were similarly treated. Extensive injuries of the gallbladder may be treated by cholecystectomy.

There were fifteen stab wounds of the stomach, eight of which were pure injuries

with a mortality rate for the two groups of 33 and 25 per cent, respectively. There were also two patients with gunshot injuries of the stomach who died. The wounds were all sutured and covered with omentum when possible. The posterior wall of the stomach must always be examined when a wound of the anterior wall of the stomach is found. This may be done through an enlargement of the wound on the anterior wall of the stomach, or by opening the lesser sac through the gastrocolic, or gastrohepatic omentum, or through the transverse mesocolon. There were seven deaths in the group; five died from shock, one from pneumonia and one from peritonitis.

There were fifteen stab wounds of the small intestine, five of which were pure injuries. The mortality rates for the two groups were 46 and 40 per cent respectively. There were also 9 gunshot intestinal injuries with seven deaths; and five nonpenetrating ruptures of the intestine with three deaths. Of the seven deaths from stab wounds, two were from shock, two from pneumonia and pulmonary atelectasis and three from peritonitis. Of the seven deaths from gunshot injuries four were from shock, two from peritonitis and one from delayed sepsis and peritonitis from an intestinal fistula. Of the three deaths from nonpenetrating injury to the small intestine, two were from peritonitis and one from shock. All intestinal wounds were sutured with the exception of those in three cases. One of these was a stab wound with injury to the mesentery necessitating resection of a portion of the illium with side-to-side anastomosis of the intestine. This patient died. The other two were gunshot injuries in which it was found necessary to resect a portion of the ilium, and were also treated by side-to-side anastomosis of the intestine. One of these patients died and the other recovered. The two patients who died did so because of peritonitis. Considering the deaths from all types of intestinal injury it may be noted that of the seventeen deaths, nine were from peritonitis, one from sepsis and seven from shock. The more recent general use of the sulfonamides intraperitoneally may be expected to reduce the deaths materially from infection in this group.

There were twelve stab wound injuries of the large intestines with one death, and seven gunshot injuries with five deaths giving a mortality rate of 8 and 71 per cent, respectively, for the two groups. All these patients were treated by suture of the perforation. The low mortality rate for stab wounds of the large intestines is rather startling, as is the fact that in this series, it is much lower than the mortality for stab wounds of the small intestines. In the one death from a stab wound of the colon in this group, the cause of death was pneumonia. Of the five deaths following gunshot wounds, two died from shock and three from peritonitis.

There were twenty-three traumatic eviscerations, eighteen of which were of the omentum, four of the small intestines, and one of the transverse colon. There were only four deaths in this group, a mortality rate of 17 per cent. Two died from pneumonia and two from peritonitis. In all cases, the eviscerated portion of the omentum was resected and the eviscerated loops of intestine were flushed thoroughly with normal saline solution and returned to the abdomen.

To summarize, there were forty-two deaths in the 115 intra-abdominal injuries in this series. Twenty-one were due to shock, eight to pneumonia, one to pneumonia and pulmonary atelectasis, eleven to peritonitis and one to liver death. It is to be noted that shock and infection are the conditions to be combatted if we are to reduce the mortality rate materially.

Postoperatively, the patients were given adequate amounts of morphine or pantopon for sedation. Those without perforation of the gastrointestinal tract were put on clear fluids for two or three days, then given a soapsuds enema, and put on a soft diet if no signs of sepsis or peritonitis had supervened. Those who were in shock, or who developed shock after operation were continued for several days on intravenous

fluids, usually 5 per cent glucose and saline, fortified with transfusions of citrated blood if necessary. There were forty patients who were admitted in shock, and twenty-five more who developed shock postoperatively in the entire series of 115 cases of intra-abdominal injury. The patients with stab wounds of the abdomen who lived received slightly more, and those who died received slightly less than 600 cc. of blood at transfusion. Ten patients admitted in shock received no blood at all, four getting well without transfusions and six dying before the blood could be procured. The patients with gunshot wounds who recovered got 1,000 cc. of blood; those who died received about 700 cc. of blood. The patients with nonpenetrating intra-abdominal injuries who recovered received an average of 700 cc. of blood, and those who died received an average of 900 cc. of blood. Those who died got less blood for the treatment of shock than the patients who lived, because they died before a sufficient amount of blood could be procured.

We realize that the amount of blood used in the treatment of shock in these cases falls considerably short of the amount that we would desire to use; but the amount used is necessarily limited by the amount on hand in the blood bank. Adrenal cortical extract should be used in addition to the transfusions of whole blood and plasma.

Patients with perforations of the gastrointestinal tract were treated as potential cases of peritonitis. They were kept adequately sedated with morphine or pantopan, and were kept on intravenous fluids with nothing by mouth until indicated. A Levine or a Miller Abbott tube was used postoperatively and in peritonitis cases, always combined with Wangensteen drainage. Those patients had been treated with sulfonamides intravenously until the danger of infection had passed. Vitamin C was given in large doses in order to promote wound healing.

The patients who developed pneumonia had their sputa typed and were treated with oxygen and the sulfonamides. Pulmonary atelectasis was treated by the inhalation of oxygen and carbon dioxide, frequent changes in position and bronchoscopy where indicated.

CONCLUSIONS

1. Abdominal signs and symptoms were present in all but ten of the 115 cases of intra-abdominal injury included in this series.

2. Abdominal signs and symptoms in intra-abdominal injury may be masked by shock and alcoholism. Of the ten patients who were asymptomatic, five were in severe shock on admission.

3. All patients are to be operated upon at the earliest possible moment, consistent with the adequate preparation of the patient and the adequate treatment of shock.

4. The importance of transfusions of citrated whole blood and plasma is stressed.

5. All cases must be thoroughly explored through adequate incisions.

6. The use of sulfonamides intraperitoneally and intravenously is indicated in all cases in which the peritoneum is contaminated from within or without.

7. All patients with gastrointestinal perforation are to be treated as cases of potential peritonitis, receiving Ochsnerization, blood and sulfonamides.

REFERENCES

Eisberg, H. B. Diagnosis and treatment of penetrating abdominal wounds. *Am. J. Surg.*, 5: 145, 1928.

Gordon-Taylor, G. Abdominal injuries and their recipients. *Brit. J. Surg.*, 26: 217, 1938.

Loria, F. L. Prognostic factors in abdominal gunshot wounds. *New Orleans M. & Surg. J.*, 80: 283, 1927–1928.

Mitchiner, P. H. and Cowall, E. M. Air raid: abdominal and pelvic injuries. *Lancet*, 1: 469, 1939.

Oberhelman, H. A. and LeCount, E. R. Peace-time bullet wounds of the abdomen. *Arch. Surg.*, 32: 373, 1936.

Selleck, W. M. Penetrating wounds of the abdomen. *Am. J. Surg.*, 118: 500, 1923.

Storck, A. H. Penetrating wounds of abdomen. *Ann. Surg.*, 3: 775, 1940.

Storck, A. H. Gunshot wounds of the abdomen. *South. Surg.*, 8: 148, 1939.

Willis, B. C. Shotgun wounds of abdomen. *Am. J. Surg.*, 28: 407, 1935.

Wilson, Frank C. Gunshot wounds of the abdomen. *South. Med. J.*, 27: 805, 1934.

Wright, L. T., Wilkinson, R. S. and Gaster, J. L. Penetrating stab wounds of the abdomen and stab wounds of the abdominal wall. *Surgery*, 6: 241, 1939.

SOLITARY CYST OF THE KIDNEY*

REPORT OF TWO CASES

LOWRAIN E. McCREA, M.D.
Associate Professor of Urology, Temple University Medical School;
Attending Urologist, Philadelphia General Hospital
PHILADELPHIA, PENNSYLVANIA

SOLITARY cyst of the kidney, although uncommon, is not as rare a clinical entity as is generally conceded. In a total of 78,518 admissions to Philadelphia General Hospital, between the years of 1939 and 1941, inclusive, eight solitary cysts of the kidney were observed. Of these eight cases, five were in association with other renal pathological disturbances. The two cases to be described came under personal observation on the Urological Service at Temple University Hospital. Both cases were diagnosed preoperatively and were proved at operation.

The first recorded instance of a diagnosis of solitary renal cyst was that of Fabricius de Hilden, who died in 1634. In 1861, Henry Thompson reported an enormous sac connected with the kidney, which was repeatedly emptied by tapping. Since that time there are numerous references in the literature. Undoubtedly, many instances of solitary cyst formation are unrecorded. Many have been discovered at autopsy or during surgical procedures.

A solitary cyst of the kidney is usually of large size, unilateral and unilocular. These cystic formations are usually observed in middle life, although many cases on record have been seen in early adult life and childhood. Hepler considers . . . "The average age incidence of 45 years, a period when vascular lesions as arteriosclerosis, endarteritis, aneurisms, infarcts and acquired lesions, such as tumor, are common."

CASE REPORTS

CASE I. B. U., a female, white, age forty, presented a history of being well until one week before admission, at which time she experienced a sharp pain in the right upper abdominal quadrant, radiating toward the genitalia. The pain continued for about twenty-four hours. Following this, she had a feeling of discomfort over the right side. After this attack and before admission to the hospital, she had two other attacks of severe pain, which lasted only a few hours. Her past medical history was negative and her family history irrelevant. On admission, a large mobile mass was palpable in the right upper quadrant. This mass moved on respiration. It was not painful to palpation. Urinalysis, on admission, showed no red cells and two to three leukocytes per field. Four days after admission, a catheterized urine specimen showed innumerable red blood cells. Retrograde pyelography revealed a left ureter and kidney that appeared normal. The right ureter was displaced anteriorly and to the left, so that it reached almost the midline of the abdomen. (Fig. 1.) The kidney calices and pelvis presented an abnormal appearance, which suggested that the kidney had become rotated. A large, soft, tissue mass on the right side was discernible and appeared to be connected with the right kidney. A diagnosis of solitary cyst was made, which was confirmed at operation. At operation the cyst was evacuated and the sac resected from the kidney parenchyma. Hemorrhage was readily controlled. There was little compression atrophy of the kidney.

CASE II. F. K., nineteen years of age, a male, white, presented a history of recurrent attacks of hematuria over a period of three years. A diagnosis of renal tumor had been made previous to admission. On admission, the urine was cloudy and the urinalysis revealed countless red blood cells. The blood picture was normal other than a leukocytosis of 16,300. Blood Wassermann was negative. At cystoscopy the bladder was negative. Indigo-carmine, following intravenous administration, was elim-

* From the Department of Urology, Temple University Medical School.

inated in four minutes from both ureteric orifices, of good ejection and intensity. An *x*-ray examination revealed a partially calcified mass in the region of the right kidney. Retrograde pyelography revealed that the large calcified mass was causing moderate compression of the renal calices from their lateral aspects. (Fig. 2.) A diagnosis of solitary cyst with calcification was made. This was substantiated at operation. Nephrectomy was deemed advisable due to the marked compression of the lower pole of the kidney. (Fig. 3.) The diagnosis of solitary renal cyst with calcification was confirmed by histologic examination. (Fig. 4.) Subsequent examinations have revealed the presence of an increasing hypertension which, in a way, was reflected to the time of original admission, when the blood pressure was found to be 130/90. The urinary findings have subsequently been found to be negative.

FIG. 1. Retrograde pyelogram showing the line of the ureter displaced toward the midline. The pelvis and calices present a definite blunted appearance.

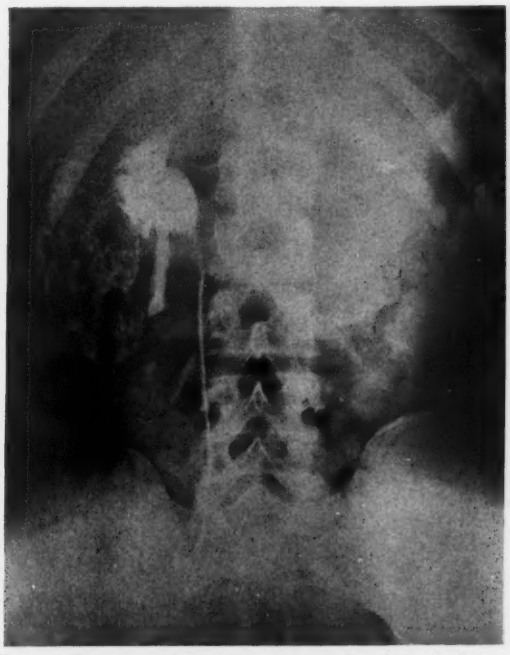


FIG. 2. Retrograde pyelogram of the right kidney showing a marked elongation of the lower calyx and considerable blunting of the upper calyx. Adjacent to the kidney can be seen an irregular ovoid mass showing varying degrees of calcification.

The etiology of solitary cyst of the kidney has never been established. There are many varied theories as to their origin. That such cysts are congenital in origin is supported by such men as Hildebrand, Davis, Kampmeier and others. Lawrence Smith, Professor of Pathology, Temple University Medical School, is of the opinion that solitary renal cysts are of congenital origin. The fact that they occur usually in middle life is supported by the fact that the few secreting glomeruli found in the walls of the cyst possess poor secreting ability. This results from the fact that embryologically they are not connected normally to the collecting renal tubules. The pressure of the secreted fluid within a thick, limiting membrane, is such to prevent rapid secretion from an otherwise abnormal glomeruli. It takes years before these cysts are of sufficient size to warrant attention or produce clinical symptoms. Caulk believed that . . . "Those who contend that all kidney cysts are of congenital origin are unquestionably making a statement which is unjustifiable." He was also of the opinion that the majority of solitary renal cysts belong to a class of retention cysts, following obstruction. Hepler believes that tubular obstruction associated

with anemia from interference with local blood supply is responsible for the formation of these cysts. He has been able,

Fig. 3. Specimen removed at operation, consisting of the kidney and the calcified cyst. Considerable pressure atrophy was noted in the lower pole of the kidney.

experimentally, to produce a renal cyst in rabbits by the blocking of the renal papillae by fulguration with simultaneous ligation of the posterior branch of the renal artery. Clinically, he believes that analogous tubular obstruction and circulatory disturbances may be produced by various pathological conditions, such as an obliterating endarteritis with peritubular sclerosis and infarct from embolus or thrombosis. He further states . . . "It would seem more reasonable to suppose that they are related in some way to the acquired renal lesions which are more common in middle life." Herbst and Polkey believe that in some instances . . . "These cysts may be due to hyperplasia of part of the elements derived from the excretory ducts, viz., that small localized tubular congenital anomalies may remain latent until middle life when they become aggravated by the circulatory disturbances which occur at this time, (arteriosclerosis, emboli, infarcts). The anemia caused by these circulatory changes may have something to do with the blowing out of the larger cysts."

Solitary cysts of the kidney, in contradistinction to polycystic disease or retention cysts of the kidney, are usually unilateral. On occasion, they may be multilocular. Such a condition is rare. Meland and Braasch reported six such cystic formations and were able to find only four previous reports. In solitary renal cysts, either side may be affected. The condition may be found in either sex, in relatively equal occurrence. Any portion of the kidney may be the site of the cyst. However, from a summary of the cases reported, these cysts are more frequently observed at the lower pole of the kidney; next in frequency at the upper pole and most infrequently in the body of the kidney. They may occur on the anterior surface or the posterior surface of the kidney. In size, they may vary from one of a few cubic centimeters in capacity to one of enormous proportion. One of such capacity was described by G. W. Fish, which contained ten liters of fluid. The largest recorded cyst was that reported by Cassioli, which contained twelve liters of fluid. In true solitary cyst, there is no communication between the cyst formation and the renal pelvis or calices. The cyst wall is usually densely adherent to the renal parenchyma and may show remnants of compressed glomeruli. The adjacent renal parenchyma is usually compressed as a result of pressure exerted by the cyst. The cyst wall is composed of dense fibrous tissue which may show extensive areas of calcification. A serous solitary cyst contains a clear, yellowish and watery fluid, composed of albumin, chlorides, epithelial cells, a few leukocytes and traces of urea. The contents of some cysts may be of a hemorrhagic nature and may even contain old clotted blood.

SYMPTOMS

There is no symptom or symptom complex characteristic of solitary cysts. A solitary cyst may produce no symptoms whatsoever, but may be discovered acci-

dently in routine examination. This is due in part to the slow growth of the cyst and the fact that there are no symptoms or

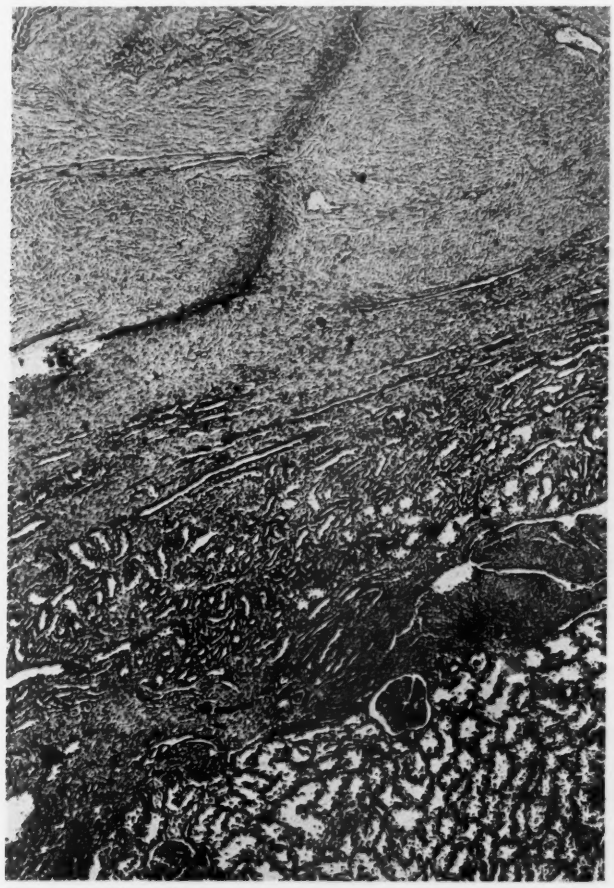


Fig. 4. Microphotograph showing the dense hyalinized fibrous cyst wall and the contiguous compressed and elongated kidney tubules.

group of symptoms that are characteristic or constant. In some instances, there is only a feeling of discomfort or weight in the loin, or a distinct dull pain is apparent. In others, the pain may be of a colicky nature —the pain of renal colic. The pain so described is often associated with other surgical lesions and is, therefore, not characteristic of solitary cyst. Occasionally, as in one of the cases here reported, hematuria is the only symptom. The content of the cyst may be of a hemorrhagic nature, but that in itself does not warrant the appearance of blood in the urine, as there is no point of communication between the cyst and the renal pelvis. Being without evident symptoms, it may be the presence of the abdominal mass which first attracts attention. The tumor is usually unilateral, firm, smooth, yet elastic. The mass does not appear fixed in the loin as it presents a definite respiratory excursion. Individual renal function tests are usually normal and it is only after extreme pressure atrophy occurs that unilateral reduction of renal function becomes apparent. The blood chemistry and the urine are usually negative although blood cells in varying numbers may be seen in some instances.

DIAGNOSIS

Due to the vague nature and inconsistent character of the symptoms, a preoperative diagnosis may be difficult or even impossible. The negative urine findings, the normal blood chemistry, and the presence of a palpable mass are confusing. Hematuria, inconstant as it is, or pain, constant, dull or severe, as occasionally observed, is not

pathogonomic. *X*-ray offers the greatest diagnostic assistance at the command of the surgeon. The plain roentgenogram of the abdomen may reveal a cyst adjacent to a kidney, presenting an ovoid or spherical appearance. This is particularly true when calcification of the wall is present. Urography, although it may be normal, usually shows some distortion of the renal pelves or calices as a result of pressure. (Figs. 1 and 2.) Cysts on the upper pole and the body of the kidney are more apt to affect the normal contour of the pelvis than those cyst formations located at the lower pole. Although a hydronephrosis may occur as a result of ureteral compression by the cystic mass upon the ureter, it is an unusual finding. The pyelogram will generally show a flattened, elongated appearance, or an elongation of a single calyx. (Fig. 2.) The differential diagnosis of solitary cyst of the kidney must exclude nearly all forms of renal disorders, especially renal neoplasm and hydronephrosis. Although it may be difficult to exclude the presence of renal neoplasm, the normalcy of the urine findings and individual renal function tests is of the utmost importance in differential diagnosis. The shadow on the roentgenogram, particularly when it can be well outlined, should be of definite diagnostic importance. In the presence of a solitary cyst, the total absence of pyelectasis and of urinary retention within the renal pelves, and the relative position of the shadow of the cyst to the renal pelvis and calices should be such as to make possible the differentiation from hydronephrosis.

The prognosis is good, although there are many factors that may enter the clinical picture. The presence or absence of complicating infection and calculi must be considered. However, the mortality should be no greater in this condition than other individuals subjected to nephrectomy when indicated.

TREATMENT

Treatment of solitary cyst is entirely surgical and should be instituted as early as possible to prevent secondary atrophic destruction of kidney tissue, resulting from the pressure of the cyst upon the renal parenchyma. Surgery is feasible unless operation is contraindicated by associated disease, making such surgical procedures inadvisable. Nephrectomy is indicated only when atrophic destruction is so extensive that to permit the kidney to remain is inadvisable. Excision of the cyst is by far the method of choice. To establish the line of cleavage between the cyst wall and the parenchyma of the kidney, resecting the cyst *in toto* is the logical procedure, when possible. However, nephrectomy may be necessary following such procedure, because of uncontrollable hemorrhage, or may be deemed advisable because of the extensive destruction of kidney tissue.

SUMMARY

1. The etiology of solitary renal cyst is not known. It is controversial whether such cysts are congenital or acquired.

2. Solitary renal cyst, although uncommon, is not rare in occurrence.

3. The condition occurs with equal frequency on the right or left side.

4. Occurrence is relatively equal in either sex.

5. The most frequent site of origination is the lower pole of the kidney. Next in frequency is the upper pole and lastly the body of the kidney.

6. The condition may be observed at any time of life, but is not commonly seen in the first two decades, but is most common between the ages of thirty and fifty years.

7. The most logical treatment is that of resection of the cyst. However, nephrectomy may be advisable because of extensive destruction of the kidney, or because of uncontrollable hemorrhage following resection of the cyst.

REFERENCES

Abel, I. Solitary cyst of the kidney. Report of a case with review of the literature. *Urol. & Cutan. Rev.*, 20: 617, 1916.

Allen, C. D. and Ragsdale, J. W. Solitary cyst of the kidney. *Am. J. Surg.*, 29: 311, 1935.

ANDRESEN, K. Roentgenology of solitary cysts. *Roentgenpraxis*, 8: 505, 1936.
ARCHER, F. B. Antiseptic nephrectomy by abdominal section; recovery. *Lancet*, 1: 1070, 1882.
ASCHNER, P. W. Solitary cyst of kidney. *Am. J. Surg.*, 5: 83, 1928.
BARNEY, J. D. Discussion. *New England J. Med.*, 199: 278, 1928.
BEGG, R. C. Solitary hemorrhagic cysts of the kidney. *Brit. J. S.*, 13: 649, 1926.
BEVERS, E. C. A renal cyst causing chronic intestinal obstruction. *Brit. M. J.*, 1: 702, 1914.
BOCKENHEIMER, C. Cystischer Tumor bei Hufeisenniere; durch Operation entfernt; Heilung. *Berl. klin. Wchnschr.*, 48: 1345, 1911.
BOCKUS, H. L., KROHN, S. E. and MULLEN, E. A. Solitary cyst of the kidney; case. *Urol. & Cutan. Rev.*, 44: 448, 1940.
BOLYARSKIY, N. N. Solitary cyst of the left kidney. *Novy, khir. arkhiv.*, 41: 267, 1938.
BOYLAN, C. E. Solitary cyst of the kidney; discussion and case report. *Illinois M. J.*, 71: 490, 1937.
BREWER, G. E. Simple cyst of kidney. *J. A. M. A.*, 50: 718, 1908.
BRIN, H. Des cystes non hydatiques du rein; symptomes, diagnostic et traitment. *Asso. Fran. d'urol. Proc.-oert.*, 15: 33, 1911–1912.
BYRUM, J. M. Solitary cyst with calcification; case. *J. Oklaboma M. A.*, 24: 365, 1931.
CABRERA, E. G. Solitary serous cysts of the kidney. *Bol. Asoc. méd. de Puerto Rico*, 1: 461, 1932.
CAHILL, G. F. Solitary cyst with resection. *Am. J. Surg.*, 8: 1290, 1930.
CAMPBELL, A. Case of cystic tumor attached to kidney simulating ovarian disease; extirpation of kidney; recovery. *Edinburgh M. J.*, 20: 36, 1874.
CARLING, E. R. Large solitary cyst of renal origin. *Brit. J. Surg.*, 22: 184, 1934.
CARSON, W. J. Solitary cysts of the kidney. *Ann. Surg.*, 87: 250, 1928.
CASSIOLI, C. Di una voluminosissima ciste solitaria del rene. *Riv. osp.*, 7: 151, 1917.
CATTANEO, M. Solitary cyst of lower pole of right kidney following abdominal injury. *Boll. e. mem. Soc. piemontese di chir.*, 3: 830, 1933.
CAULK, J. Obstructive calcareous papillitis; retention cysts of the kidney. *Tr. Am. A. Genit.-Urin. Surgeons*, 7: 228, 1912.
CLUTE, H. F. Simple serous cysts of the kidney. *Surg. Clin. North America*, 4: 1453, 1924.
COLSTON, J. A. C. Solitary cyst and papillary cystadenoma occurring simultaneously in one kidney. *J. Urol.*, 19: 285, 1928.
COLSTON, J. A. C. Calcified cyst of the kidney. *Bull. Johns Hopkins Hosp.*, 51: 125, 1932.
COOPER, S. Solitary cyst of the kidney. *Texas State M. J.*, 33: 697, 1938.
CRABTREE, E. G. Discussion. *New England J. Med.*, 199: 278, 1928.
CROSBY, A. H. Solitary cyst of the kidney. *New England J. Med.*, 199: 277, 1928.
CUNNINGHAM, J. H. Large solitary and multiple cysts of the kidney. *Surg., Gynec. & Obst.*, 23: 688, 1916.
DAMM, E. Solitary cysts. *Ztschr. f. urol. Chir.*, 102: 113, 1932.
DAVIS, J. E. The surgical pathology of malformations in the kidney and ureters. *J. Urol.*, 20: 283, 1928.
DEAN, A. L. Treatment of solitary cyst of the kidney by aspiration. *Tr. Am. A. Genito-Urin. Surgeons*, 32: 91, 1939.
DE FARIA, G. and FIALHO, A. Solitary cyst partially calcified and ossified; value of excretory urography in diagnosis; case. *Hospital, Rio de Janeiro*, 14: 241, 1938.
DOZSA, E. Clinical data on large serous cysts of kidneys. *Ztschr. f. urol. Chir.*, 22: 70, 1927.
DOUGLAS, J. Solitary cyst of the kidney. *Ann. Surg.*, 76: 656, 1922.
FANG, H. C. Solitary cyst of the kidney. *Chinese M. J.*, 53: 221, 1938.
FISCHER, K. Solitary cysts of the kidney 3 cases. *Arch. f. klin. Chir.*, 185: 356, 1936.
FISH, G. W. Large solitary serous cysts of the kidney. Report of 32 cases including 2 cases cured by aspiration and instillation of 50% dextrose solution. *J. A. M. A.*, 112: 514, 1939.
FORBES, R. D. Solitary cyst of the kidney. *Surg. Clin. North America*, 13: 1357, 1933.
FOWLER, R. S. Simple serous cysts of the kidney. *New York M. J.*, 940: 1109, 1911.
FUENTES, B. V., SCHUNK, A. and BUNO, W. Large solitary cyst of the kidney; case. *Arch. urug. de med., cir. y. especialid.*, 18: 541, 1941.
FULLERTON, A. Solitary cysts of kidney. *Brit. J. Surg.*, 14: 629, 1927.
GEISINGER, J. F. Solitary cyst of the kidney. *Urol. & Cutan. Rev.*, 40: 778, 1936.
GRAVES, R. C. Congenital solitary kidney with large solitary cyst. *J. Urol.*, 23: 555, 1930.
GREENBERG, B. E., BRODNEY, M. L. and ROBINS, S. A. Solitary cyst of the kidney; review of co-existing pathology. *Am. J. Surg.*, 23: 271, 1934.
GREENBERG, A. L. Right solitary renal cyst; left renal calculus. *J. Urol.*, 42: 87, 1939.
GAULTIEROTTI, M. M. Solitary cysts of the kidney; clinical and roentgen study of 3 cases. *Urologia*, 6: 103, 1939.
GUTIERREZ, R. Large solitary cysts of the kidney; types; differential diagnosis and surgical treatment. *Arch. Surg.*, 44: 279, 1942.
HARE, C. J. Cystic kidney weighing 16 pounds. *Tr. Path. Soc. London*, 3: 131, 1850–1851.
HARPSTER, C. M., BROWN, T. H. and DELCHER, A. Solitary unilateral large serous cysts of kidney. *J. Urol.*, 11: 157, 1924.
HEPLER, A. B. Solitary cysts of the kidney. *Surg., Gynec. & Obst.*, 50: 668, 1930.
HERBST, R. H. and POLKEY, H. J. Solitary renal cysts. *J. Urol.*, 37: 490, 1937.
HERBST, R. H. and VYNALIK, W. J. Solitary serous renal cysts. *J. A. M. A.*, 96: 597, 1931.
HERBST, R. H. and APFELBACH. Hyperplasia of kidney. *Surg., Gynec. & Obst.*, 61: 306, 1935.
HIGGINS, C. C. Solitary cyst of the kidney. *Ann. Surg.*, 93: 868, 1931.
HIGGINS, C. C. and LAVIN, E. J. Solitary cysts of kidney. *Radiology*, 23: 598, 1934.
HILDEN, F. DE. Quoted by Kirwin.
HINMAN, F. Principles and Practice of Urology. Philadelphia, 1935. W. B. Saunders Co.
JOSEPH, M. A case of large solitary cyst of kidney. *J. Urol.*, 17: 245, 1927.
JOSEPH, M. Large renal cyst (simulating solitary cyst). *J. Urol.*, 28: 297, 1932.

Jowers. Case of renal tumour; excision of kidney; death; remarks. *Lancet*, 1: 13, 1884.

Judd, E. S. and Simon, H. E. Hemorrhagic cysts of the kidney. *Surg., Gynec. & Obst.*, 44: 601, 1937.

Junker, H. Diagnosis of solitary cysts of the kidney. *Ztschr. f. Urol.*, 29: 709, 1935.

Kampmeier, O. F. A hitherto unrecognized mode of origin of congenital renal cysts. *Surg., Gynec. & Obst.*, 36: 208, 1923.

Keeling, J. H. Extirpation of kidney. *Brit. M. J.*, 2: 1299, 1882.

Kirwin, J. Calcified renal cyst. *J. Urol.*, 15: 273, 1926.

Klopp, E. J. and Fetter, T. R. Solitary cyst of kidney. *Surg. Clin. North America*, 14: 220, 1934.

Kretschmer, H. L. Solitary cyst of the kidney. *J. Urol.*, 4: 567, 1920.

Kretschmer, H. L. Solitary cyst; five cases. *J. A. M. A.*, 95: 179, 1930.

Krusen, W. Cyst of kidney simulating ovarian cyst. *J. A. M. A.*, 11: 140, 1906.

Ladinski, L. J. Cystic tumor of kidney. *Med. Rec.*, 69: 524, 1906.

Lamson, O. F. Solitary cyst of kidney. *Northwest. Med.*, 29: 206, 1930.

Latteri, S. Le cisti solitarie sierose del rene. (Studio clinico, anatomico-patologico e. sperimentale.) *Arch. ital. d'urol.*, 6: 113, 1930.

Lazarus, J. A. Solitary cyst of the kidney; 2 cases. *Urol. & Cutan. Rev.*, 35: 698, 1931.

Livermore, G. R. Solitary cyst of the kidney; case. *Memphis M. J.*, 10: 13, 1935.

Lockyer, C. Enormous renal cyst. *Proc. Roy. Soc. Med., London, Sec. Obst. & Gynec.*, 6: 97, 1912–1913.

McArdle, J. S. Nephrorrhaphy and nephrectomy. *Dublin J. Med. Soc.*, 97: 207, 1894.

McConnell, A. A. Solitary cyst of the kidney. *Dublin J. Med. Soc.*, 4: 270–273, 1920.

McKay, R. W. Solitary cysts of the kidney. *South. M. J.*, 25: 234, 1932.

McKim, G. F. and Smith, P. G. Solitary serous cysts of the kidney. *J. Urol.*, 12: 235, 1924.

McMurtry, L. S. Large cyst of the kidney; nephrectomy: recovery. *South. Clin.*, 16: 266, 1893.

Meadow, S. Nephrectomy for large cyst of kidney. *Brit. M. J.*, 2: 44, 1871.

Meland, E. L. and Braasch, W. F. Multilocular cysts of kidney. *J. Urol.*, 29: 505, 1933.

Modini, U. Solitary cyst of the kidney; case. *Clin. med. ital.*, 66: 540, 1935.

Morton, C. A. A clinical lecture on a case of gigantic retroperitoneal tumour, intimately connected with the kidney, which simulated ascites from tuberculous peritonitis; with a report of the pathology of the tumor, By E. V. Dunkley. *Lancet*, 2: 520, 1908.

Moynihan, G. B. A. Partial nephrectomy with three illustrative cases. *Brit. M. J.*, 1: 263, 1902.

Nash, F. W. G. Solitary cyst of the kidney; case. *Brit. J. Urol.*, 6: 253, 1934.

O'Neil, R. F. Solitary serous cyst of the kidney, with the report of a case. *J. Urol.*, 14: 269, 1925.

Ormond, J. K. Solitary cyst of the kidney. *Am. J. Surg.*, 6: 241, 1929.

Parmenter, F. J. Type of cystic kidney amenable to surgical intervention. *New York State J. Med.*, 21: 73, 1921.

Pedrosa, G. and R. Solitary cyst of the kidney; cases. *Vida nueva*, 44: 181, 1939.

Purslow, L. Cystic tumour of the kidney. *Brit. M. J.*, 1: 884, 1913.

Quinby, W. C., and Bright, E. F. Solitary renal cysts; symptoms when situated at upper pole of right kidney. *J. Urol.*, 33: 201, 1935.

Ravich, A. and Turkeltaub, S. M. Solitary cysts of the kidney. *Urol. & Cutan. Rev.*, 41: 261, 1937.

Robinson, L. J. and Wilder, W. O. Simple solitary renal cyst. *J. Urol.*, 40: 10, 1938.

Schmidt, A. Solitary cysts of the kidney. *Ztscbr. f. Urol.*, 34: 476, 1940.

Scholl, A. J. Hemorrhagic cysts of the kidney; case. *J. Urol.*, 41: 103, 1939.

Schulman, M. Unilocular cyst of the kidney. *New York M. J.*, 104: 218, 1916.

Schwartz, J. An unusual unilateral multicystic kidney in an infant. *J. Urol.*, 35: 259, 1931.

Schwyzer, A. Solitary cyst of the kidney; two cases. *Minnesota Med.*, 20: 474, 1937.

Shih, H. E. and Wu, S. D. Solitary cyst of the kidney (case). *Chinese M. J.*, 59: 259, 1941.

Smith, L. D. Solitary serous renal cysts. *Illinois M. J.*, 52: 291, 1927.

Smith, G. G. Solitary cyst of the kidney. *Boston M. & S. J.*, 190: 691, 1924.

Stevens, A. R. Solitary cyst of the kidney; excision of cyst with suture of kidney. *Am. J. Surg.*, 19: 140, 1933.

Stevens, W. E. Solitary cysts; case in which preoperative diagnosis of cyst involving central portion of lone kidney was confirmed by operation. *Urol. & Cutan. Rev.*, 37: 698, 1933.

Stirling, W. C. Large solitary hemorrhagic renal cyst; review of literature. *J. Urol.*, 25: 213, 1931.

Thomas, B. A. Enormous solitary cyst of the kidney associated with pyonephrosis. *J. Urol.*, 18: 528, 1927.

Vonacher, J. R. and Springer, A. Solitary cyst of the kidney; report of a case. *Illinois M. J.*, 51: 413, 1927.

Walker, Sir. J. Thomson. Relation of calcified abdominal glands to urinary surgery. *Proc. Roy. Soc. Med., Sect. Urol.*, 16: 45, 1923.

Walter, W. A Case of nephrectomy for cystic tumour of a floating kidney. *Brit. M. J.*, 2: 615, 1883.

Wasmuht, K. Solitary cyst of the kidney; case. *Zentralbl. f. Cbir.*, 67: 2259, 1940.

Weil, R. Concerning a distinct type of hypernephroma of the kidney which simulates various cystic conditions of that organ. *Ann. Surg.*, 66: 418, 1907.

Zeissler, E. P. Cyst of the kidney. *Internat. J. Surg.*, 27: 252, 1914.

THEORY AND THERAPY OF SHOCK*

REDUCED TEMPERATURES IN SHOCK TREATMENT

FREDERICK M. ALLEN, M.D.
NEW YORK, NEW YORK

CLARITY may be gained by abandoning the former term of "primary" shock and replacing it with syncope, vasomotor collapse or any other expression that can be accurately defined. The single word, shock, will be used here to denote the condition formerly called "secondary" shock. A slight abbreviation of Moon's latest definition may suffice: *Shock is a disturbance of fluid balance resulting in a peripheral circulatory deficiency manifested by reduced volume and flow and increased concentration of the blood, with anoxia.*

My former publication (January 1939) devoted space to the hypothesis that the inflammation from a local injury is equivalent to shock, when it merely becomes large enough to cause systemic symptoms. That manuscript was submitted before I was aware of Moon's 1938 book, which felicitously compressed this same idea into an aphorism: "The wheal is shock in miniature."

Suboxidation and increased capillary permeability (locally or systematically) dominate the picture of shock from beginning to end, and lead to death by anoxia. The process which draws water and electrolytes into the tissue spaces from the blood and possibly also from the cells may be attributed to three possible causes, namely, an increased avidity of the tissues, a vital alteration in the capillary endothelium, or a shift of osmotic balance due to metabolic products either of the original injury or of suboxidation. Though these are probably different aspects of the same process, the point of view may have practical consequences as explained later.

The present work consists of several hundred experiments on rats, dogs and a few cats. Though each experiment generally required about thirty hours of continuous observation, the limitations of space permit only brief summaries of most of the findings. By trials in many directions it was attempted to find methods which could be easily duplicated to yield constant invariable results, not mere percentage differences. As the principles and technic are important, they will be explained as fully as the results.

METHODS

Production of Shock. I have not felt in agreement with the recommendations of the National Research Council that present research be limited to hemorrhage, burns and mechanical trauma, as the forms of shock typically encountered in battle. If it be granted that slow or intermittent hemorrhage leads to final shock, several authors (Moon, Wiggers) nevertheless affirm that hemorrhage cannot be dependably standardized; also the hemorrhage itself is an independent disturbance and complication of capital importance which has been the subject of well known disputes. Ashworth and Kregel's finding of a different partition of intra- and extracellular water and electrolytes in hemorrhage and traumatic shock appears as a fundamental distinction. Burns cannot be exactly standardized. Also, notwithstanding improved apparatus (Duncan and Blalock) it seems probable that owing to the different conformation of different animals' legs, the standardization of muscle trauma is not very precise.[9,13,15,16] Furthermore, therapeutic experiments aiming at survival for more than two days are

* From the Department of Physiology and Biochemistry, New York Medical College. Aided by a grant from the Committee on Scientific Research of the American Medical Association.

hampered by the prostration of hemorrhage, the uncertainties introduced by masses of burned or necrotic tissue and the liability to infection. It, therefore, seems more instructive to attempt study of an ideal "pure" shock. Noble and Collip have sought this ideal by tumbling animals in a wheel, and they justly emphasize the advantages of freedom from hemorrhage, anesthesia and infection. They disregard the possibility of maximal psychic and nervous accompaniments of the mild physical trauma.

The method of placing tourniquets on limbs was devised for my former research and continued in the present one because it involves nothing from beginning to end except the recognized shock processes of reduced oxidation and increased vascular permeability. Nervous factors are excluded by the total paralysis of nerves. There is inflammatory edema, sometimes greater than with mechanical trauma, to suit the upholders of the physical theory, and asphyxial metabolic products to suit the upholders of the toxic theory of shock. Recovery can be complete without infection or the death of a single tissue cell. The standardization is most accurate and elastic, because it can be regulated by two variables, namely, the mass of tissue ligated and the duration of ligation. The briefest possible ligation of the largest possible mass creates the least chance of hemorrhage, while at the opposite extreme legs ligated for nine or ten hours are subject to bleeding which discolors the local tissues and may influence subsequent blood counts. This escape of blood, however, is a recognized feature of the vascular changes in the severest inflammation, and is thus different from the gross rupture of vessels by trauma.

The reports of Noble and Collip and of Blalock, that the results of ligation were unreliable, may be explained as errors of novices with the method, due usually to irregular placement or later slipping of the tourniquet, wrong anesthesia, incomplete stasis due to looseness, or thrombosis due to undue tightness of the tourniquet. Statistics of a large number of animals, perhaps just received in variable states of feeding or fasting, turned over to technicians or assistants for mass trials, without later checking by examination or autopsy to learn the reasons for failure, are less reliable than a smaller series in which the preliminary condition of every dog is known and every detail is personally carried out and watched.

Mylon, Winternitz and associates have given instructions for efficient constriction with rubber tubing, which doubtless most workers will use. From force of habit and partly with a notion of their adjustability and freedom from slipping, I have continued to make tourniquets of stationers' rubber bands looped together to form the necessary length, with a string at each end for tying. The animal is placed with the groin particularly in view; the thumb of the left hand guides the successive superimposed turns of the rubber in this area which is important in relation to thrombosis, while the fingers on the lateral surface pull the skin down as far as possible so as to include a maximum tissue mass and form a slight pad to hinder slipping. Until we can obtain the desired apparatus for narrow constriction with a measured air pressure, the tension of the tourniquet must be governed by experience. The chief danger is thrombosis, which tends to prevent shock and cause later gangrene. This danger varies with the size of the animal and its blood vessels. Care is needed to prevent its occurrence sometimes with five-hour ligations of rats' legs; it should never occur with five-hour ligations in dogs or cats; with nine-hour ligations it is mostly avoidable but may occur infrequently. Dogs and cats are left untrammeled under anesthesia, but rats are confined in individual cages narrow enough to prevent turning and meddling.

Wiggers' assertion that "efforts to devise a standard procedure that unfailingly produces shock seem as hopeless today as in 1903" was unjustified in 1942. Each

investigator can adjust standards as exactly as desired according to his strain of animals or experimental conditions, but the following rules will hold approximately.

For strong normal rats, a four-hour ligation of one hind leg is never fatal. A five-hour ligation is always fatal, unless the animal is particularly strong or has food or water during or shortly before the experiment. Average rats survive the five-hour ligation if they are given a subcutaneous or intraperitoneal injection of physiological saline early enough. More severe and fatal shock results from ligation of both hind legs for four hours. When a rat is held head downward to allow the viscera to fall toward the diaphragm, a low abdominal tourniquet makes fatal shock if applied for one and one-half to two hours. When this ligation is for one and one-half hours or slightly less, all male rats, which survive the shock, die later from urinary retention and hydronephrosis, but females can recover. The paralysis in all cases passes off within a few weeks.

Average dogs and cats withstand ligation of one hind leg for five or six hours and of both hind legs for about four hours. Ligation of both hind legs for five hours is fatal (with one exception in this series, perhaps a fault in technic). Ligation of one hind leg for nine hours is fatal. The survival period has not been standardized in a sufficient number of untreated animals, but with different degrees of severity it can be made to range from two to eight hours or longer.

The shock thus produced has been compared when necessary with the complicated forms of shock resulting from muscle trauma, burns or hemorrhage. Theoretically, however, the simplest form of standardized shock might be obtained by dehydration. The familiar injections of hypertonic sodium chloride solution are painful and the intense inflammation may be hemorrhagic; also the body is flooded with the electrolyte. In 1913 for a different purpose I described injections of dextrin, and suitable subcutaneous or intraperitoneal doses of this or some other hydrophilic colloid may furnish an accurately standardized shock without nervous factors, anesthesia, hemorrhage or unknown toxins.

Anesthesia. At different times three plans have been followed in rats: (1) It is feasible to ligate limbs without anesthesia, because the tourniquet sinks easily into the soft tissues and rapidly paralyzes the nerves. (2) Relaxation of muscles is more convenient, and at one time the rats were momentarily etherized for the ligation. (3) Recently nembutal intraperitoneally has proved most convenient, but as the tourniquet is in position for several hours the anesthesia ends long before that time, and prior to release of the limb the rat is lively and apparently comfortable.

As rats seem to suffer less tourniquet pain than human subjects, dogs and cats seem to suffer even more, presumably because of their firm unyielding muscles. Therefore, full surgical anesthesia is indispensable, and in the present series this has been obtained with nembutal intraperitoneally, reinforced with morphine subcutaneously in refractory animals if necessary. The effect seldom lasts throughout the ligation period. Toward the end of this period the nerves are paralyzed and placid dogs are awake and seemingly comfortable, needing no anesthetic. The crying of excitable dogs is probably psychic, and is quieted with a fractional dose (one-third or one-fourth of the original dose) as correctly recommended by the Mylon-Winternitz group. The removal of the tourniquets ends all distress and the animals are free from drug effects before the onset of any severe shock.

Shock production being essentially the same with all the variations mentioned in rats and dogs, anesthesia may safely be dismissed as a significant disturbing factor.

Hemoconcentration during ligation, as mentioned also by the Mylon-Winternitz group, may amount to a rise of a million or even two million red cells, or may be absent. Possible causes are: (1) shock from the tourniquet itself; (2) the anesthetic;

(3) dehydration, rats being more susceptible than dogs; (4) more or less swelling of legs even when the tourniquet seems tight, perhaps due to blood vessels protected by bone, one leg often being swollen while the other is not. Tentatively, a plan of giving each dog 200 cc. of water by stomach tube at the beginning of ligation seemed to prevent this rise in the blood counts, but the trials were too few for certainty. These initial variations have been without apparent significance for the observations made during the later stages of shock.

Morphine subcutaneously or nembutal intraperitoneally have also proved satisfactory in fractional doses during these later stages, even when absorption of salt solution is inhibited or ascites present. Therefore, intravenous dosage has not appeared necessary.

Other Methods. Local refrigeration was accomplished as usual by immersing the animals' legs in ice water. There is no difficulty in thus chilling the legs of dogs and cats while keeping the bodies warm and dry, in a warm room, with warm coverings or if necessary with the addition of hot water bottles. The small size and incorrigible struggling of rats prevented any such success. There were harmful effects from either continuous anesthesia, or immobilization in a plaster cast, or the wetting and chilling of the body when the restraint was less secure.

Hemoconcentration was judged by erythrocyte counts. These involve a slight difference from hematocrit readings because of the evident changes in corpuscle size under some conditions. Otherwise only primitive clinical observations were made, with the addition of certain special laboratory examinations for which thanks are expressed to the co-operators. The main work was restricted essentially to survival experiments, and tedious repetition will be the only means of obtaining needed data which could have been easily available if facilities had existed at the time. The limitation during many years to experiments such as could be carried out from the first preparation to the final clean-up strictly single-handed has irretrievably ruined far-reaching plans; but it at least provides a personal grasp of details and a demonstration that some simple results can be obtained under conditions that were calculated to make research impossible.

My former work suggested two possible approaches to shock treatment. One was refrigeration, and the original intention was to confine the present investigation to this method. The other approach was later included, however, and will form the subject of a second paper.

EXPERIMENTS

Until the kindness of Dr. O. M. Cope opened the opportunity of working in volunteer status in his laboratory, I lacked facilities for continuing my earlier experiments and it was, therefore, natural that the problem should be taken up by others. Blalock has agreed that chilling of the injured part tends to prevent shock, and in the treatment of existing shock reduced temperature prolonged life, both in his own experiments with local chilling of traumatized limbs and in his experiments with Mason on reduction of general body temperature in shock produced by either hemorrhage or muscle trauma. These obviously accurate and valuable findings may still be subject to clarification in the following respects:

1. Surgeons will agree that shock which kills in about six hours is severe. It is not a mild or border-line condition. Therefore, a lengthening of life may have been the utmost that could be expected of such treatment. The differences were not trivial. In the series with local temperature changes, the heated animals lived for an average of five hours forty-nine minutes and the chilled ones for an average of eleven hours twenty-four minutes. With full appreciation of a desire for clinical conservatism, it must be noticed that from a strictly scientific standpoint the conclu-

sions against refrigeration in both these papers are opposite to the findings.*

2. In the alterations of body temperature, Blalock and Mason mentioned that the reductions were sometimes so great as to be inapplicable clinically. Temple Fay has shown that death can occur from excessive lowering of temperature and from smaller reductions improperly produced. There is lack of a control series to show whether Blalock and Mason employed hibernation technic such as would be approved by Fay and what mortality might have occurred in their hypothermic animals without shock. The lengthened survival with cold is all the more remarkable because observers in the first World War and subsequently found cold to be an important factor in inducing and aggravating shock. Blalock, in 1934, reported that the onset of shock in anesthetized dogs was not particularly affected by cold. Obscurity concerning the reasons for these differences, together with Blalock's cautious interpretation of his latest experiments, may partly explain why a reviewer such as Andrus entirely ignores temperature reduction in the prevention or treatment of shock and recommends the out-dated practice of artificial warming, and why this practice which contains possibilities of important harm is still enforced in some military services.

Elman, Cox, Lischer and Mueller found that the survival of severely burned rats was longest at an environmental temperature of 75°F., and it was markedly shortened by heating the environment to 99°F. or cooling it to 55 or 32°F. This result seems to indicate that a moderately subnormal body temperature is most beneficial in shock resulting from burns.

During the proof reading of this paper, Wakim and Gatch published their experiments on environmental temperatures, performed by placing rats, guinea pigs, rabbits and dogs on cold or warm surfaces. To the clinician the essential knowledge is the temperature of his patient, not of the bed, and amid the variables of shock one cannot be calculated from the other. These experiments do not demonstrate the optimum body temperature because no records of body temperature were included.

In following the Wakim-Gatch technic for dogs and rats merely anesthetized for three to five hours, additional fractional doses of nembutal were found necessary occasionally in the absence of shock. The temperature of dogs is influenced in such procedures by their size, thickness of hair and other variables; but without data for guidance, short haired dogs weighing 4.5 to 5.8 kg. were used. After some hours at a room temperature of 25°C. or 77°F., their rectal temperatures ranged from 101.4 to 102.2°F. Barbiturate administration to the point of surgical anesthesia always reduces the temperature. With the abdomen merely resting on a metal tray at room temperature, the rectal temperature of the unconscious dog falls gradually to between 97 and 95°F. With the abdomen on bottles containing water at 35°C., the rectal temperatures fell to levels between 99.6 and 100.5°F. Resting similarly on bottles at 45°C., there was moderate hyperpnea with rectal temperatures up to 102 to 102.6°F.

Albino rats of 125 to 250 Gm. weight, when huddled comfortably together, had the uniform rectal temperature of 100°F. Under anesthesia, with the abdomen resting on a metal tray at room temperature of 25°C. (77°F.), the rectal temperature fell rapidly to the minimum of 90 to 88°F. Resting on wood instead of metal, the rectal temperatures fell to between 94 and 88°F., depending on the size of the rat and the depth of anesthesia. On uncovered bottles containing water at 35°C., the rectal temperatures ranged between 96.6 and 98.4°F., mostly 98°F. On uncovered bottles containing water at 45°C. the rectal temperatures rose to 103 to 104°F., with hyperpnea. But Wakim and Gatch state that their bottles were cloth covered. Repeating the experiments with this insulation, the water at 35°C. gave rectal temperatures ranging from 96 to 99°F., according to the size of the rat and

* An editorial in the *J. A. M. A.*, February 6, 1943, incorrectly attributes the idea of reduced temperature to Blalock and to Williams. Owing to the system of controlling large research funds, my original findings were limited chiefly to rats, and Blalock's authoritative confirmation in dogs has been valuable. His therapeutic pessimism, based on the usual failure of the refrigerated animals to recover ultimately, has been consistently expressed in his papers and in a lecture before the New York Academy of Medicine on January 7, 1943. My present experiments offer the first method for uniform recovery of refrigerated animals from fatally severe existing shock.

the depth of anesthesia. Water at 45°C. gave rectal temperatures from 101 to 103°F. according to the same variables, with hyperpnea. All these rectal temperatures would presumably have fallen lower if the water had been allowed to cool as described by Wakim and Gatch in the course of their rat experiments.

Thus, the fall of body temperature which is so marked with surgical anesthesia at 25° atmospheric temperature is not entirely prevented by resting the animals on water bottles at 35°C. But Wakim and Gatch furthermore produced shock by exposure of viscera and stripping of intestine. Assuming that this procedure had its usual powerful effect in reducing temperature, and that therefore the animals of Wakim and Gatch had body temperatures appreciably lower than those recorded above for merely anesthetized animals, their experiments must be interpreted as follows: Their shocked animals on ice bags died quickly because their body temperatures fell far below the limits which have been found safe in artificial hibernation. Their animals at room temperature had notably long survivals with very low body temperature. The longest survivals in all species were in the groups at 35°C., which presumably had body temperatures slightly below normal. Placing the animals on bags at 45°C. presumably raised the body temperature to a full normal level, and thus caused early death. These assumed interpretations are identical with the conclusions which I established experimentally for rats in my 1939 paper.

Wakim and Gatch have rendered valuable service in adding experimental and theoretical warnings against the prevalent practice of overheating patients in shock. Until the optimum body temperature is positively demonstrated for large species such as dog and man, there is danger that too much wrapping in blankets may be nearly as harmful as heating devices. No change has been made in the conclusions of the present paper as already written, but in this war emergency the numerous readers of the *J. A. M. A.* should not decide uncritically whether a mildly reduced body temperature in shock is a beneficial reaction or an injury requiring correction.

Still more recent notes favorable to reduced temperature in shock are those of Waters, Perry and Fay (*J. A. M. A.*, 121: 783, 966 and 1109, 1943).

3. As Blalock's results were considered inconclusive by himself, they could have been carried farther in three ways: (1) A milder and more precisely standardized form of shock might be used to decide whether reduced temperature can actually save life. (2) As I formerly showed that refrigerated limbs can be segregated by a tourniquet for long periods without harm or shock, intermittent ligations of this kind might be used to allow time for systemic recovery. (3) Adjuvant treatment might be employed. An important advantage of Blalock's undercooled animals was that they were alive long after the controls were dead. Temperature reduction may render a sufficient service if it can keep wounded men alive or postpone the severest stage of shock until other treatment is obtainable.

LOCAL CHILLING WITHOUT TOURNIQUET

In order to gain preliminary information with less expensive animals, many time-consuming attempts were made with rats, resulting in complete failure. The harmfulness of cold was illustrated when the animals were wet and shivering, with reduced rectal temperatures. Struggling was also conducive to shock by reason of exhaustion, and too much anesthesia was detrimental. For these reasons the rats with their hind legs in ice water sometimes died sooner than the controls, and results were hopelessly mixed because of the failure to develop a satisfactory method for such small animals.

There was no difficulty with dogs (and a few cats) which had been routinely subjected to ligation of both hind legs for five hours. The legs were then immediately immersed in ice water and constant supervision maintained for twenty-four to thirty-eight hours, usually thirty hours. Rectal and esophageal temperatures were taken frequently, the former being often several degrees lower than the latter even with the thermometer inserted several inches. Red cell counts were taken from ear veins every two or three hours. The dogs were tied as lightly as possible. If obstreperous, they

could be kept quiet with minimal doses of nembutal without affecting the experiment. Their position was changed occasionally for comfort, and every five or six hours they were rested by being given liberty on the floor for a few minutes. Such experiments are so simple that only the results need be summarized.

In all instances the lengthened survival reported by Blalock was confirmed. The differences were not small, for while the untreated dogs died in three to seven hours, no treated animal survived less than fourteen hours; some lived twenty-two to twenty-eight hours, and two were returned to their cages in supposedly fair condition after thirty hours but died when unwatched during the ensuing twelve hours. Also it was not a mere prolongation of a half-dead hopeless state, because often the treated dogs could still wag their tails cheerfully when the controls were dead. Nevertheless, the ultimate outcome was fatal, as Blalock described. Without the labor of dissecting and weighing legs, it was obvious from examination both during life and at autopsy that the local swelling was delayed rather than prevented. As the edema accumulated the red cell counts rose and the symptoms increased, until death occurred under essentially the same conditions as in the untreated animals, only later.

Instead of an accumulation of statistical figures under a single fixed plan, the work consisted mainly of a variety of orientation experiments, scarcely any two groups exactly alike, with milder degrees of shock, more efficient refrigeration or simple adjuvant treatments, in the attempt to demonstrate a positive saving of life. The possibility is not excluded that with the right degree of shock and with better methods, perhaps also extended over a longer time, this result might be obtained. It can only be recorded that these numerous trials did not disclose any plan whereby animals would positively die if untreated and would positively recover under treatment by refrigeration alone.

This failure was found to be retrieved by fluid administration in the form of water liberally by stomach, or water and milk alternately, or subcutaneous injection of 200 to 500 cc. of physiological saline. It did not seem a fair experiment to let these animals die by dehydration or for lack of enough fluid to provide for their leg edema. Trials of several variations of this plan showed that dogs with positively fatal shock produced by ligation of both hind legs for five hours could definitely recover, that their symptoms were mild and their red cell counts increased by no more than two million, if the fluid administration was begun soon after removal of the tourniquets and the legs were chilled for thirty hours. Control animals collapsed too rapidly to get the benefit of the fluid, which was lost by vomiting or diarrhea or found at autopsy in the stomach or under the skin.

The effectiveness of this method was found to be limited, because it was unable to save dogs which had both hind legs ligated for seven or nine hours; also, after the five-hour ligations, if there was a delay of one to two hours between the removal of the tourniquets and the beginning of treatment, the survival was only lengthened and was not permanent. Other trials showed that when the fluid administration was intensified the refrigeration period could be shortened, and vice versa. Other gradations appeared when it was found that with barely fatal degrees of shock, some dogs could be saved by prompt intensive fluid administration without refrigeration. Two questions then became prominent: First, within what limits of severity or duration of shock can local refrigeration be demonstrated as life-saving in comparison with normal temperature controls? Second, as the human leg is so much thicker than that of the dog, and the living tissue is such a powerful thermal insulator unless its blood supply is seriously reduced, also as treatment in human shock cases can seldom be immediate, are the results in dogs sufficient in magnitude to promise substantial benefits in patients?

At about this stage it was learned that experiments along this line were being well and successfully conducted in another laboratory. This labor was, therefore, relinquished in favor of those who were equipped to make more rapid progress and to gather more comprehensive data. Only an extensive preliminary exploration having been made, only one positive conclusion is drawn from this phase of the work, namely that dogs with certain degrees of fatal shock due to asphyxia of the hind legs can be saved permanently by suitable chilling of the legs together with administration of fluid by stomach or subcutaneously.

The clinical application could have advanced more rapidly except for the scarcity of suitable cases in the City Hospital. Dr. Lyman Weeks Crossman hopes to make a report on the use in compound fractures and other conditions of shock and infection in the limbs. This method also has the advantage of applicability to superficial lesions in other parts of the body, which means preeminently burns, also frost-bite. As burns make up an important part of war casualties and the cold does not interfere with accepted methods of treatment, it has been unfortunate that this clinical study could not be pushed more rapidly. It can be stated at least that the few observations to date give definite encouragement as regards the influence on pain, shock, vesication and infection.*

LOCAL REFRIGERATION WITH TOURNIQUET

This part of the work had been conducted simultaneously with the preceding, and was carried a little farther because it seemed unlikely to be duplicated elsewhere. With the tourniquet the term refrigeration is better justified because the limb, either animal or human, can be chilled through-and-through to minimal temperatures which are never obtainable without the tourniquet or some other severe obstruction to the circulation. This method also stops hemorrhage.[13]

* Allen, Crossman, Safford. Reduced temperature treatment for burns and frost-bite. To be published.

This treatment is conformable with either of the two theories of shock. Under one theory, there is cessation of absorption of a toxin and of its further formation. Under the other theory the outpouring of local edema is checked. Two procedures are possible and were tried. One is to imitate the plan formerly used in strychnine experiments, namely, to remove the tourniquet only very briefly at long intervals at first, then gradually to lengthen the free periods and shorten the ligation periods, until after long treatment the body will have disposed of the otherwise fatal quantity of poison. Under this plan the tourniquet is replaced in the same or nearly the same location each time, and the explanation can be conceived equally well as a delay of edema formation which allows time for the circulation to compensate. The other plan is to remove the tourniquet at various intervals and to replace it a little lower each time. The amount of tissue subject to either toxin production or edema formation is thus reduced gradually to the vanishing point; also the danger of vascular damage and thrombosis is supposedly lessened by placing the tourniquet always at different levels. Trials were made of a wide range of tourniquet application and release, and a combination of the two plans was finally adopted; namely, the tourniquet was removed for very short periods at first and later for gradually lengthened periods, and it was replaced each time about 1 cm. below the former level. The first "short" release of the tourniquet ranged in different trials from two minutes to fifteen minutes, and this was lengthened gradually to thirty minutes after twenty-four hours. The dogs were given freedom on the floor during part of these free periods. The periods of continuous ligation and refrigeration ranged in different trials from one hour to six hours, and were gradually shortened toward the close of treatment. The temperature readings, blood counts and other observations were made in the same way as in the experiments without tourniquet.

Rats bore refrigeration better with the tourniquet than without, the chilling of the body being naturally much less. With shock produced by ligation of one hind leg for five or six hours or of both hind legs for four hours it was frequently possible to save life, but this success was entirely illusory. With the soft tissues and small blood vessels of the rat, thrombosis always occurred; and as it was absent in the controls, it evidently resulted from repeated ligations of a badly asphyxiated leg in spite of refrigeration. It was not prevented by replacing the tourniquet always at a new level. Although gangrene of one entire hind leg is fatal in the larger species, about half the rats were able to survive, but such recovery has no significance for the problem of shock.

In dogs, the discrepancy between rectal and esophageal temperatures was less than without the tourniquet, and often the two were practically equal. In spite of the evident paralysis of nerves, there were some complaints over the repeated ligations when they were high up, but the requirements for sedation were very small. The influence on shock was evidently more powerful than without the tourniquet, but it was a disappointment that no such animals were permanently saved by refrigeration alone, even when the treatment was extended as long as thirty-eight hours. These dogs could remain remarkably lively after the untreated controls were dead, but the typical blood changes and fatal outcome were only delayed. Several dogs retained exceptionally normal blood counts and general condition and seemed to recover brilliantly, but in each instance the apparent success proved to be due to thrombosis, followed by gangrene and death within a few days.

Although the results were poorest when tourniquets were removed for long periods at the beginning of treatment, the legs swelled to an unexpected degree even when the free intervals were very short. The swelling even seemed to increase while the tourniquets were in place. The apparently tight tourniquets may have failed to block circulation totally because of the firmness of the chilled tissues, or it may be possible to think of the unknown rate of simple diffusion through cold tissues and other uncertainties. The advance of hemoconcentration and fatal symptoms in parallel with the large edema formation in the legs seems favorable to the physical theory of local fluid shift. On the other hand, various experiences leave the impression that when a moderately advanced stage of shock is reached, amputation no longer saves life, even if shock and fluid accumulation in the stump are prevented by refrigeration, so that the continued rise in cell counts after such an amputation may need to be explained in chemical terms, namely, as a general capillary change due either to a primary toxin or to anoxia.

With the tourniquet, dogs were enabled to make even better use of water or milk by stomach tube or subcutaneous saline injections than without the tourniquet, and survival was favored accordingly. The blood counts were kept within safe limits and permanent recovery was obtained not only after five hours of ligation of both hind legs, but also in trials of seven hours and nine hours of ligation, representing a severity of shock which had proved incurable without the tourniquet. It was not possible thus to cure a dog which had been subjected to a nine-hour ligation of both hind legs, with a delay of one hour between the removal of the tourniquet and the beginning of treatment.

Again, the provision of fluid to relieve dehydration and compensate for local edema formation seemed reasonable and fair as an experimental plan. In clinical application, there is the certainty that human limbs can be thoroughly chilled with the aid of a tourniquet, and if the refrigeration can retard shock for many hours during which the patient remains able to profit by adjuvant treatment, the benefit will be genuine.

An important obstacle to this use of the tourniquet must be given full emphasis,

namely, the frequency of thrombosis. The incidence is erratic; for example, not a single dog developed thrombosis in both hind legs, but there was a high percentage in one hind leg even after the five-hour ligations, when there is practically no thrombosis in the controls or after refrigeration alone; and after seven-hour or nine-hour ligations this complication was very difficult to avoid. The fact that my former demonstration of fifty-four hours of ligation-refrigeration of normal animals' legs without thrombosis does not hold good for damaged legs should not add unduly to the prevalent prejudices against tourniquets. It is readily shown in experiments that wounds, or the nutritive damage resulting from long asphyxia at room temperature, furnish starting points for thrombosis which can then spread disastrously in spite of refrigeration. This danger is inversely proportional to size; it is greatest in rats, less in cats, still less in dogs, and apparently least in man. On Dr. L. W. Crossman's service at City Hospital, trials of six or eight hours' refrigeration-ligation of ulcerated or infected arteriosclerotic legs have proved harmless. Dr. Crossman received a report from another hospital where the traumatized arm of a young man was kept packed in ice with a tourniquet for forty-eight hours continuously, and after amputation the part of the stump distal to the tourniquet had good vitality and healed well. For this and other reasons it is unfortunate that there has been no cooperation with a view to the value or limitations of the method for military use. On the existing evidence it is only possible to suggest the following rules, which are conservative perhaps to an unnecessary degree:

(1) A tourniquet should not be used without a positive indication or a planned purpose. One example is a permanent tourniquet to be left in position until after a hopelessly mangled limb has been amputated, as advised in the former World War.

(2) The only indication for a temporary tourniquet at ordinary temperature is uncontrollable hemorrhage. The limb should then be kept at the lowest temperature that is feasible without freezing. At certain intervals the circulation should be restored either momentarily or for a time governed by the effectiveness of local pressure for controlling bleeding. The time limit of continuous tourniquet application should be half an hour in summer weather and longer in proportion as the temperature is lower.

(3) If refrigeration is available, it is a safe aid for inhibiting some degrees of shock, more or less superficial infections, etc., without a tourniquet. Temple Fay has emphasized the value for gas-forming infections.

(4) A tourniquet may be used with refrigeration for controlling hemorrhage, or more severe shock, infection or pain, or for anesthesia preparatory to operation. The safe time of application to a wounded limb is at least three or four hours and probably much longer, depending partly on the character of the wound.

(5) For extreme emergencies of shock or wounds which might require ligation-refrigeration for ten to twenty-four hours or longer, the use of heparin may assure safety, because the animal experiments indicate that there is no danger except thrombosis.

(6) If the shock or other emergency is serious enough to threaten life, the tourniquet and refrigeration can be used for the longest times without heparin. There is a fair chance of absence of harm; but if thrombosis occurs, an amputation can be performed without other anesthesia and life can be saved at the cost of the limb.

GENERAL HYPOTHERMIA

Local reduction of temperature can be very radical in degree, but its range of application is confined practically to the limbs or superficial areas. Reduction of general body temperature has the advantage of being applicable to shock from any source, but physiologically it is very different because the safe degree of cooling is so slight in comparison with limb refrigera-

tion. Besides the lengthened survival in the previously mentioned experiments of Blalock and Mason, the possible benefit of hypothermia in shock is suggested by the following considerations:

(1) Temple Fay, the originator of this general principle, is convinced of the value for shock in his clinical experience. It is not clear whether his observations pertained to nervous injuries or the hemoconcentration type of shock.

(2) There is full agreement of authorities that death from shock is due not to toxemia but to anoxemia. Fatal tissue anoxia results from the diminution of both volume flow and oxygen content of the blood. Total metabolism is reduced because the cells cannot obtain enough oxygen for their vital activities; it is an internal suffocation. When there is struggling, shivering and increased vascular contraction from cold, it is easy to understand how bodily reserves are used up and the demand for oxygen increased, and the traditional influence of cold in aggravating shock is thus explained. But the patient with obtunded sensibilities in deep shock does not react to cold with shivering, and the reduced metabolic activity in artificial hibernation entails less oxygen consumption. The brighter red color of the blood was noticed by Blalock (1934). This reduction of the oxygen need to compensate for a deficient supply corresponds to the principle employed in local refrigeration.

(3) In my previous investigation it was noticed that the labile temperature of rats is subject to marked spontaneous reduction during shock. The shocked rats will not huddle together for warmth; they resist every kind of attempt to warm them; they live far longer at moderately low temperature and die quickly if they are artificially warmed to normal temperature. The exquisitely efficient instincts and defense reactions of the rat, here illustrated, are in accord with the theoretical explanation in the preceding paragraph.

(4) Chambers and his co-workers discovered that rats placed in an icebox survived hemorrhages which were fatal at room temperature. Theoretically, the cold might favor contraction of blood vessels, and if the rats were torpid at reduced body temperature their metabolic needs would be reduced. While hypothermia thus apparently prevents hemorrhagic shock, there seems to be reason to doubt that it could save rats which were allowed to go into shock before the treatment was begun. Strictly, therefore, the contribution suggests cold as a new aid in the management of acute hemorrhage and probably of shock combined with fresh hemorrhage.

(5) Blalock, in 1934, noticed that chilled dogs were extremely sensitive to pentobarbital, less so to morphine. Barrows and Dodds recently have suggested from observations on mice that reduced body temperature may be a means of reducing the dose and lengthening the effect of anesthetics. Fay's discovery of the relief of pain by crymotherapy, likewise Parker's recent experiments, may find application when pain is present with shock.

In beginning the present experiments, it was deemed desirable to develop a technic by using normal cats as controls. Contrary to accepted ideas, morphine is the best sedative for this purpose in cats as well as dogs. The initial excitation which has disturbed cats and physiologists is obviated by a preliminary injection of nembutal, after which the animals can be kept asleep with repeated minimal doses of morphine for several days if desired. The body temperature is then easily reduced with ice bags, and later a dormant hypothermic state is maintained with very little use of cold or drugs, this being the artificial hibernation discovered by Fay. The continuity is such that finally when left in a room of average warmth the animals may require twelve to twenty-four hours to regain their normal temperature and activity. Care must be taken to prevent the hypothermia from becoming too extreme. Rectal temperatures of about 90°F. are conservative for workers who lack Fay's skill. Not only is too severe or too prolonged hypothermia

fatal, but it must be remembered that methods which tax the strength of normal animals cannot be a suitable treatment for a badly weakened state of shock. Reductions of the rectal temperature to about 90°F. were selected as suiting the needs in shock, and were well tolerated by normal cats. Nevertheless, a series of such hibernations with one or two days of rest between are fatal to cats, which are not seriously weakened by the same duration of simple fasting. This seems to confirm the opinion of most observers that crymotherapy is a strain upon the bodily strength. The greater stamina of human beings as compared with cats or even dogs may partly explain Fay's accomplishments in the degree and duration of temperature reduction in patients, but deficiencies in my own technic must also be considered.

Preliminary observations with various degrees of shock produced by leg ligations in cats showed that death might be hastened when the body temperatures accidentally fell to 80°F. or lower, and within conservative limits of about 90°F. the prolongation of life was not striking and positive as in rats. The supply of cats was temporarily cut off by cold weather, but the results up to this point seemed disappointing as regards any permanent preservation of life by hypothermia, even with the lightest degrees of shock that could be counted on as fatal for controls.

Further opportunities were furnished by the experiments with local refrigeration in dogs. When these animals are completely or partially awake, they maintain approximately normal body temperatures with very little aid; but if they are kept asleep with small cautious doses of nembutal or morphine, the chilling effect of the hind legs in ice water must be counterbalanced usually by warming of the body. Here again, excessively low body temperatures continuing for several hours result fatally in spite of subsequent warming. In several trials when the body temperature was held at selected levels from 90°F. up to normal, no benefit was perceptible. Rather, an approximately normal temperature seemed to be accompanied by a slightly better preservation of strength, so that in actual practice normal body temperatures were preferred in these experiments. The chilling of the hind legs, which were the source of shock, may perhaps have accomplished all that was possible with cold. The slight impairment of strength may perhaps be blamed upon the deeper anesthesia. The main point seemed to be that the hypothermia did not exhibit any countervailing benefits.

In subsequent experiments with fluid injections, a comparison was made between two closely matched dogs, which were shocked by five-hour ligations of both hind legs and afterward treated identically, except that the body temperature was allowed to remain normal in one, and in the other it was kept at approximately 90°F. by ice bags applied to the foreparts with strict avoidance of the hind legs. The same small intraperitoneal injections of nembutal were given to both, though the hypothermic dog was thus kept asleep while the normothermic one was only drowsy. Both animals survived, with only a slightly noticeable inferiority of strength in the hypothermic one. This dog refused to eat and three days later was unexpectedly found dead, with a small amount of thick pus in the peritoneum at autopsy. This was the only instance in the entire series of chilled or nonchilled animals in which nembutal injections led to infection, but it may suggest some degree of lowering of resistance by moderate reduction of body temperature.

It is conceivable that hypothermia has the double effect of retarding both the course of shock and the recovery process, on account of depressed function of the liver or other sensitive viscera. The pressure of other phases of the research together with the duties of medical practice necessitated dropping the problem at this point, but it would be misleading to leave the impression of a definitive failure of hypothermia. The planned continuance of the

work would have followed up the beginning made by Blalock and Mason. Accepting their finding that a point is reached in shock when the hypothermic animals are alive and the controls kept at normal temperature are dead, the possibility is open that the living animals may be capable of permanent recovery with the aid of other treatment. This suggestion corresponds to the experience with local refrigeration, and it may reconcile and harmonize all the seemingly conflicting evidence. Temple Fay's position need imply nothing more than that the course of shock is retarded, exactly as Blalock and Mason found, and that the patient is thus enabled to recuperate with the aid of medical and nursing care.

This interpretation, together with the observation of Chambers, suggests that in emergencies of shock and hemorrhage at least the temporary survival of the patient until he can obtain further treatment is favored by lower rather than higher temperatures. There are obvious common sense reasons why extreme exposure calls for treatment by reasonable warming. Also extremes in treatment should be avoided by practitioners until the uncertainties have been settled by experts. There is already good reason, however, for believing that a slightly subnormal temperature in a shocked or bleeding patient is a harmless and beneficial reaction. The coverings should not be excessively warm, and in particular artificial heating is injurious theoretically and according to the unanimous experimental results.

CONCLUSIONS

1. The method of producing shock by asphyxia of limbs has been described, especially with reference to accuracy of standardization, freedom from complications and suitability for therapeutic experiments with recovery.

2. Local refrigeration, which was formerly found effective for preventing shock, is also helpful in the treatment of shock originating from the limbs and presumably other bodily areas which can be efficiently chilled. The survival of shocked dogs is lengthened by simple refrigeration of the injured legs, and still more by prolonged or intermittent tourniquet application with refrigeration.

3. The essential therapeutic effect of these measures is a retardation of the shock process, affording a greatly lengthened time for other treatment and better ability to respond to it. Within limits, the lengthened survival can be converted into permanent recovery by the simple administration of fluids by stomach or salt solution subcutaneously.

4. The simple local refrigeration is harmless. The only danger from the most prolonged tourniquet application with refrigeration is thrombosis. Certain rules were provisionally suggested for conservative clinical application of these methods for shock and complications, with a particular view to military uses at present.

5. The investigation of systemic hypothermia was left unfinished, and the conclusions are limited to a warning against the misuse of artificial heat and a suggestion of the advantage of slightly subnormal temperature. Extreme measures should be held in abeyance until they can be tested by further research.

REFERENCES

1. ALLEN, F. M. Studies concerning glycosuria and diabetes. Harvard Univ. Press, 1913. Local asphyxia and temperature changes in relation to gangrene and other surgical problems. *Tr. Ass. Am. Phys.*, 52: 189–194, 1937. Experiments concerning ligation and refrigeration in relation to local intoxication and infection. *Surg., Gynec. & Obst.*, 68: 1047–1051, 1939. Physical and toxic factors in shock. *Arch. Surg.*, 38: 155–180, 1939. Reduced temperatures in surgery. III. Experiments on pelvic and abdominal refrigeration with especial reference to traumatic and military surgery. *Am. J. Surg.*, 55: 451–466, 1942.
2. ANDRUS, W. D. Present concepts of the origin and treatment of traumatic shock. *Surg., Gynec. & Obst.*, (*Internat. Abstr. Surg.*) 75: 161–175, 1942.
3. ASHWORTH, C. T. and KREGEL, L. A. Changes in the body water partition and extracellular electrolytes in shock. *Arch. Surg.*, 14: 829–839, 1942.
4. BARROWS, E. F., and DODDS, H. Body temperature of mice during anesthesia. *Am. J. Physiol.*, 137: 259–262, 1942.

5. Blalock, A. Influence of exposure to cold and of deprivation of food and water on the development of shock. *Arch. Surg.*, 29: 1055–1068, 1934. Principles of Surgical Care. Shock and Other Problems. St. Louis, 1940. C. V. Mosby Co. A comparison of the effects of the local application of heat and of cold in the prevention and treatment of experimental traumatic shock. *Surgery*, 11: 356–359, 1942. (With Mason.) A comparison of the effects of heat and those of cold in the prevention and treatment of shock. *Arch. Surg.*, 42: 1054–1059, 1941. (With Duncan.) The uniform production of experimental shock by crush injury: possible relationship to clinical crush syndrome. *Ann. Surg.*, 115: 684–697, 1942.

6. Chambers, R. et al. Personal communication. Publication forthcoming.

7. Crossman, L. W., Allen, F. M., Hurley, V., Ruggiero, W. and Warden, C. E. Refrigeration anesthesia. *Anesth. & Analg.*, Sept.–Oct., 1942.

7a. Elman, R., Cox, W. M., Lischer, C. and Mueller, A. J. *Proc. Soc. Exper. Biol. & Med.*, 51: 350–351, 1942.

8. Fay, T. Personal communication. Cf. also Smith, L. W. The use of cold in medicine. *Ann. Int. Med.*, 17: 618–636, 1942.

9. Gutman, H., Olson, W. H., Levinson, S. O., and Necheles, H. A study of the effects of isotonic serum and saline infusion following trauma in dogs. *Am. J. Physiol.* 137: 355–361, 1942.

10. Harkins, H. N. Recent advances in the study and management of traumatic shock. *Surgery*, 9: 231–294, 447–482 and 607–655, 1941.

11. Moon, V. H. Shock. Its Dynamics, Occurrence and Management. Philadelphia, 1942. Lea & Febiger.

12. Mylon, E., Winternitz, M. C., Katzenstein, R. and de Sütö-Nagy, G. J. Studies on mechanisms involved in shock. *Am. J. Physiol.*, 137: 280–298, 1942.

13. Noble, R. L. and Collip, J. B. A quantitative method for the production of experimental traumatic shock without haemorrhage in unanaesthetized animals. *Quart. J. Exper. Physiol.*, 31: 187–199, 1942.

14. Parker, G. H. General anesthesia by cooling. *Proc. Soc. Exp. Biol. & Med.*, 42: 186–187, 1939.

15. Scull, C. W., and Eiman, J. Physiologic and clinical basis for treatment of shock. *Clinics*, 1: 43–58, 1942.

16. Wakim, K. G., and Gatch, W. D. The effect of external temperature on shock. *J. A. M. A.*, 121: 903–907, 1943.

17. Wiggers, C. J. The present status of the shock problem. *Physiol. Rev.*, 22: 74–123, 1942. (With Werle and Cosby.) Observations on hemorrhagic hypotension and hemorrhagic shock. *Am. J. Physiol.*, 136: 401–420, 1942.

A NEW OPERATION FOR THE REPAIR OF THE CRUCIAL LIGAMENTS OF THE KNEE

FRED H. ALBEE, M.D.
Consultant Orthopedic Surgeon, Hospital for Joint Diseases
NEW YORK, NEW YORK

NO joint in the human body is liable to such a diverse legion of severe and trivial injuries as the knee joint. And of all this host of injuries, there is none that is more frequently overlooked, but in the literature and in life, than the avulsion or rupture of the crucial ligaments. Resultant abnormal movement of the tibial plateau upon the femoral condyles is very important and should always be tested for.

In all active people (especially in those athletically inclined) and those whose occupations require strenuous labor, early repair of ligamentous ruptures is urgent since excessive use of unstable knee joints usually results in damage to the semilunar cartilages and development of local osteoarthritis that impair the results of any subsequent operation.

In this series of nine cases which have been done over a period of seven years, sufficient time has elapsed and data are now available to evaluate the procedure. The posterior ligament was ruptured in only one case. In three cases, both ligaments were gone and in one case, the result was not satisfactory because of limitation of motion. In all other cases, the results as to stability and motion were good. No patient was operated upon who did not present marked anteroposterior laxity. In one case not in this series, the anterior crucial ligament was found ruptured at primary exploratory arthrotomy through the split patellar approach. It was successfully sutured with silk and was not diagnosed preoperatively.

Clinicians have made a great point of formulating different operative procedures according to whether the posterior or anterior crucial ligament has been involved. Yet, from a study of a good many cases, both before and after reconstruction procedures have been attempted, it is my firm conclusion that the fundamental principle of treatment should be the same whether both ligaments or only one of them has been involved. That is, the attempt should be made to hold the head of the tibia firmly anteriorly in relation to the lower

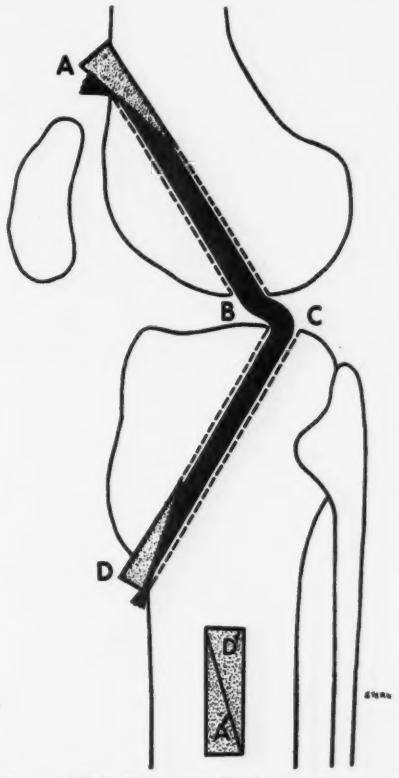


FIG. 1. This diagram discloses the general scheme of the operation. The black indicates the fascia lata extending through the drill holes into the condyles of the femur and the head of the tibia and traversing the joint at B. Extreme tension at B and C is firmly held by bone-graft keys at A and D which are obtained from the head of the tibia at A′ and D′.

Fig. 2.

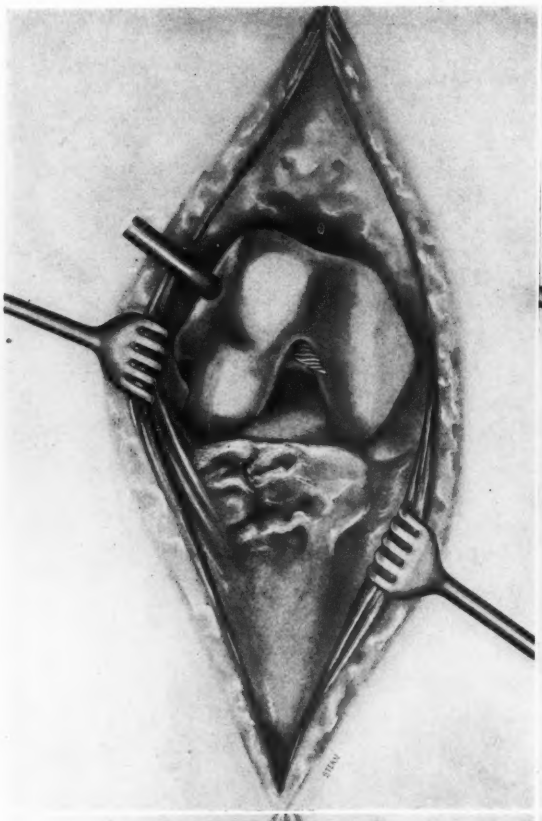
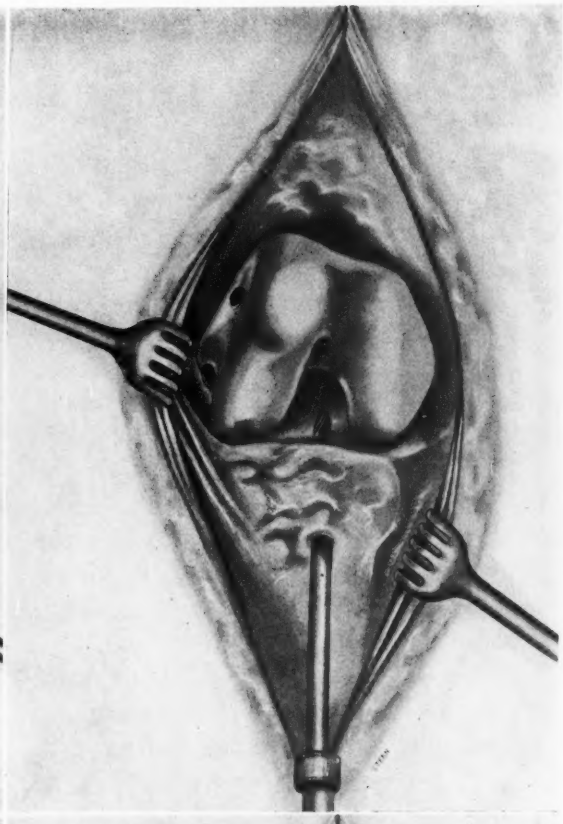
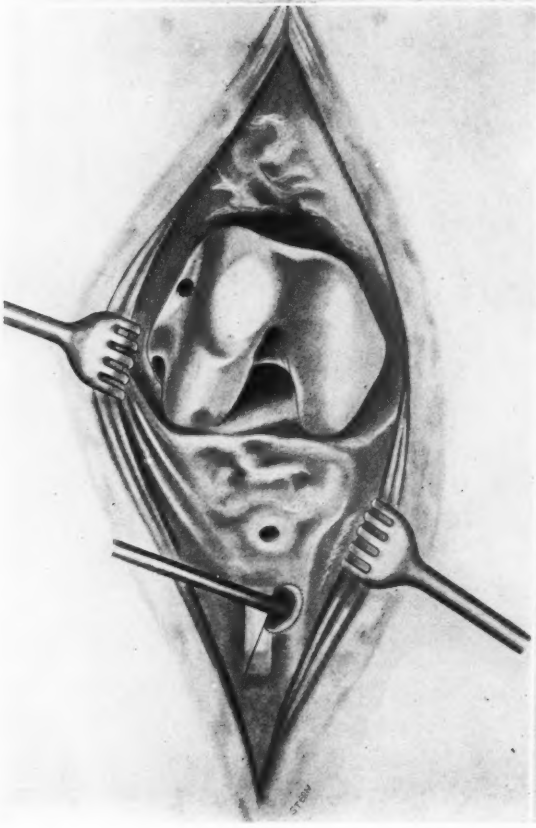


Fig. 3.





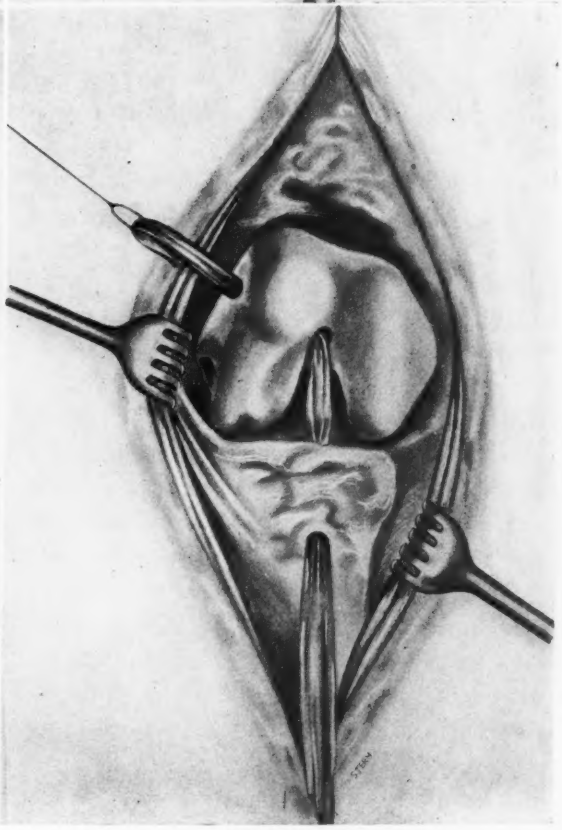


Fig. 4.

Fig. 5.

For descriptive legend see opposite page.

end of the femur in both instances, unless there is a marked laxity in the opposite direction. Therefore, in replacing the crucial ligament, the attachment of the new ligament should be relatively anterior on the lower end of the femur and posterior on the head of the tibia. It should be placed with a tension equal to that of the normal ligaments. In other words, at the time of insertion, the new ligament should have as nearly as possible the tension of a banjo string or bow string. This cannot be permanently accomplished by the anchorage of either end of the new ligament to soft tissues, periosteum, capsule, etc., and allow early removal of immobilization and both active and passive motion with weight-bearing, which is most important in order to restore complete motion and function. Rather the new ligament must have the very firmest anchorage possible, an anchorage so designed that it will also permit the greatest amount of tautness to be maintained. As to the tear of the posterior ligament or where from the tear of the anchorage ligaments between the head of the tibia and the condyles of the femur, the tendency to displacement is in the opposite direction; that is, the tibial head luxates forward, and this can be just as readily controlled as in the case of luxation in the opposite direction by merely changing the relation of the drill holes in the head of the tibia and the condyles of the femur. In other words, the hole in the tibia is placed anteriorly to that in the femur.

In formulating a new operation for the repair of the crucial ligaments, it was my desire to effect one which would produce as little traumatization to the knee itself as possible, and the dissection around the knee should be at the minimum. This is most important if complete motion and painless function is to result. Therefore, from this standpoint, it is desired that the living material for replacement should be obtained from as great a distance from the knee joint as possible, and that structures such as tendons, etc., which have to do with normal function, should not be used for repair material unless absolutely necessary. Since the researches of Allison and Brooks upon animals and clinically have proved the permanence and dependability of detached grafts of fascia and especially fascia lata as transplants, and these findings have been confirmed by both Gallie and myself in a large number of operations of widely varying character over many years from all standpoints, fascia lata seemed in this instance to be first choice for repair material. One of the severest tests of this material when used to replace ligaments extending through joints has been that of recurrent dislocations of the shoulder in epileptics. In a number of such cases, dating back to over twenty years, fascia lata has proved in my hands its trustworthiness and permanency for such use.

My principal excuse in offering a new operation in this field is the fact that I have seen a number of failures resulting from others' technics, and it is my belief that the principal reason for these failures has been too long postoperative immobilization, that the fascia lata replacing these ligaments has not been held permanently taut enough, the laxity increasing with the passage of time. I have believed, too, that some of the undesirable results may have been due to the poor or inaccurate placement of the new ligament. One influence leading to these types of failure, I believe, has been occasioned by the erroneous assumption that it is necessary to have a fascial or tendonous

FIG. 2. This diagram shows a 3/8 inch drill penetrating the condyles of the femur with its exit at the intracondylar notch.

FIG. 3. This diagram indicates drill of the same size as mentioned in Figure 2 penetrating the plateau of the tibia markedly posteriorly.

FIG. 4. This diagram indicates the obtaining of the bone-graft key wedges (with the motor saw) from the upper end of the anterior internal surface of the tibia.

FIG. 5. This diagram indicates the fascia lata (which has been obtained from the upper portion of the thigh) in place in the drill holes in the tibia and femur.

graft pedicled in order to insure viability and permanency. This misconception has also had an unfortunate influence in bone-graft technic.

In any event, the anchorage of the replacing fascia to soft parts has a pronounced tendency to yield immediately or slowly to the severe tension which must occur, not only from pressure coming from early normal function or undue strain. The use of fascia lata left attached at the region of the head of the fibula serves no helpful purpose but actually handicaps the surgeon most materially, in that it necessitates an undue amount of dissection in the immediate neighborhood of the joint. The anchorage of the fascia to the head of the fibula is uncertain and may yield, and also it is so far away from the location of the crucial ligament that it does not serve to maintain sufficient permanent tension of the new ligament. In this respect, it should be noted, that in every previously reported operation for the repair of the crucial ligament, the fascial or tendonous material has been attached to soft parts: the head of the fibula, the periosteum, the joint capsule, or some other similar anchorage in the periphery of the joint. The fascia in the technic herein described is obtained with a minimum amount of dissection, at a distance from the knee joint and in any desired dimensions or strength required. An Esmarch's bandage and tourniquet high on the thigh is used so that a bloodless field is assured.

The joint is entered through the midline by a split patellar vertical incision which brings the surgeon with ample exposure directly to the operative field with the least amount of trauma, and removes the danger of postoperatively increasing the laxity of the capsule which results from the transverse patellar incision and does much less damage to the synovial membrane. This approach which the author has used in every case of exploratory arthrotomy for over twenty years, is less damaging and safer than the peripatellar incision. Because of the straightness of this incision, early flexion of the knee tends to pull together both the fragments of the patella as well as the soft parts throughout their extent, whereas in the case of the tortuous peripatellar incision, the synovial membrane tends to pull away from the top and bottom of the patella from the tension produced by early knee flexion. The author has seen four cases in which this happened and sometime afterward, the knee joints were found filled with hematomas, the results of which were disastrous. By vertical split patellar approach, the damage to the crucial ligaments is plainly visible and the new ligament can be placed with greatest precision.

A drill hole, 3/8 inch in diameter, (Fig. 2) is made obliquely through the outer condyle of the femur from an anterior external point to a point in the intercondylar notch which is well anterior, if it is desired in the particular case to hold the head of the tibia forward on the femoral condyles and prevent it luxating backward. If the opposite is the case and the head of the tibia luxates during function forward on the condyles, this drill hole should be placed more posteriorly. A drill hole the same size is then made through the same incision through the outer anterior portion of the tibia to a point as near the insertion of the crucial ligaments to the head of the tibia as possible, or well posteriorly if the tibial head luxates backward or anteriorly, or if it luxates forward. (Fig. 3.) The necessity of accurate determination of the amount and character of the motion of the tibial plateau upon the femoral condyles before operating cannot be too much stressed so as to place drill holes accordingly.

An incision high up on the thigh of the same side at the anterior outer aspect lays bare the fascia lata from which the graft—seven inches in length, and one to one and one-half inches in width, in the adult—is obtained. With a small flexible probe, through the eye of which is placed a silk loop, this fascia lata is then pulled through the drilled holes both in the head of the tibia and the condyles of the femur. (Fig. 5.) The leg is then straightened from its

flexed position. The fascial graft is firmly keyed into the tibial hole by means of a bonegraft wedge (Fig. 4) obtained from the anterior interior broad surfaces of the tibia at its upper end; (Figs. 1 and 5) the fascia lata at the femoral side is then held very tight by means of the pull of an assistant upon a clamp placed upon it, and a bone-graft key similar in nature to the one just set in the tibia, is driven into femoral hole holding the fascia lata firm and under severe tension. (Fig. 1.)

Immobilization in a plaster of Paris cast from the groin to the base of the toes, with the knee in five to ten degrees of flexion, follows for a period of two weeks (an improvement over the usual eight to seventeen weeks reported in the case of certain other operations) after which the knee is mobilized by physiotherapy, particular attention being directed to establishing motion and developing the quadriceps extension muscle.

The advantages of the procedure herein reported are: (1) It does not use for repair purposes tendon or any other structures which have to do with function of the limb, (2) It disturbs to the minimum the peri-articular structures other than the least possible traumatizing approach to the knee joint; there is no local dissection which has been a distinct disadvantage of previous operations. Even the repair material is obtained at a distance from the joint. (3) According to the literature, no operation has been designed which because of insecure anchorage of the living repair material to periosteum, capsule or other soft parts, allows less than six weeks of immobilization. The new ligament must maintain its tension and only bony anchorage will assure this when weight-bearing and motion are allowed as early as two weeks after the operation. When this tension is maintained, it is found that attention to the lateral ligament is rarely necessary. The fascia is held in the grip of the bone-graft wedges so firmly that there is no danger of its loosening its tension from the moment of its insertion. One author definitely states that he has had stiff knees and failures from 120 days of postoperative immobilization.

REFERENCES

Groves, E. W. Hey. Operation for the repair of the crucial ligaments. *Lancet*, 2: 674, 1917.

Smith, S. Alwyn. The diagnosis and treatment of injuries to the crucial ligaments. *Brit. J. Surg.*, 6: 176, 1918–1919.

Groves, E. W. Hey. The crucial ligaments of the knee joint; their function, rupture and the operative treatment of the same. *Brit. J. Surg.*, 7: 505, 1919–1920.

Edwards, A. H. Operative procedures suggested for the repair of collateral ligaments of the knee joint. *Brit. J. Surg.*, 8: 266, 1921.

Krida, Arthur. A general utility incision for exploration of the knee joint. *J. Bone & Joint Surg.*, 7: 212, 1925.

Gallie, W. E. and LeMesurier, A. B. Repair of injuries to the posterior crucial ligament of the knee joint. *Ann. Surg.*, 85: 592, 1927.

Primi, I. and Ferrari, R. C. Traumatic rupture of the crucial ligaments with reconstructive treatment. *Semana méd.*, November, 1929.

Caeiro, J. A. Reconstruction of the crucial ligaments. *Buenos Aires, S. A.*, August, 1934.

Campbell, Willis C. An operation for repair of the internal and external lateral ligaments of the knee joint. *Surg., Gynec. & Obst.*, 60: 214, 1935.

Campbell, Willis C. Reconstruction of the anterior cruciate ligament. In press.

Campbell, Willis C. Repair of the ligaments of the knee. *Surg., Gynec. & Obst.*, 62: 964, 1936.

Cubbins, W. R., Callahan, J. J. and Scuderio, C. S. Cruciate ligament injuries. *Surg., Gynec. & Obst.*, 64: 218, 1937.

Valls, Jose. Traumatic lesions of the knee. *Dia. Med* October, 1941.

THE CONTROL OF ACUTE THROMBOPHLEBITIS WITH ULTRAVIOLET BLOOD IRRADIATION THERAPY*

GEORGE MILEY, M.D.
Clinical Professor of Pharmacology, The Hahnemann Medical College and Hospital
PHILADELPHIA, PENNSYLVANIA

THE sudden appearance of acute thrombophlebitis is one of the most unpredictable and unwelcome complications encountered in medicine. The relative inability of the various methods in vogue today to control this complication satisfactorily is well known and will not be discussed here.

In the last four years we have used the Knott technic of ultraviolet blood irradiation therapy in thirteen consecutive cases of thrombophlebitis with highly satisfactory results. Blood irradiation was found to control the classical symptoms of acute thrombophlebitis rapidly and efficiently in all thirteen cases, which included thrombophlebitis with and without fever, following delivery, operation or acute pyogenic infection.

The Knott technic of ultraviolet blood irradiation therapy has been described elsewhere.[1,2,3] Briefly, it consists of the withdrawal and citration of a predetermined amount of the patient's blood, plus immediate reinjection of that citrated blood through a Knott Hemo-irradiator, a precision machine which automatically exposes the citrated blood to intense ultraviolet rays safely and efficiently, and returns the irradiated blood to the venous circulation of the patient.

We believe that as a result of our observation a new phenomenon, that of a rapid subsidence of the classical symptoms of thrombophlebitis following ultraviolet blood irradiation, has become apparent.

RESULTS

Tabular Presentation. The following table of results, as may be readily seen, essentially shows the type and location of the acute thrombophlebitis in each patient, the time of disappearance of pain, tenderness, edema, and fever (when present), the number of blood irradiations per patient and the number of hospital days elapsing between the initial blood irradiation and discharge from the hospital. (Table 1.)

Analysis of Table. An analysis of the above table shows a definite uniformity of response to ultraviolet blood irradiation therapy. Pain and tenderness disappeared first as a rule; fever if present, disappeared next most rapidly, and edema was last to subside.

Cases 1, 2, 5, 9 and 13 are examples of failures of chemotherapy plus bed rest, local heat, and elevation of the extremity which responded successfully to ultraviolet blood irradiation therapy.

Cases 3, 10 and 11 failed to respond to local heat, bed rest, and elevation of extremity, until blood irradiation was applied.

Case 4 was seen after failure of local heat, bed rest, elevation of the extremity, and of four nerve blocks to alter the course of the disease; an advanced induration of the leg was present also. In all of these nine individuals, as well as in the other four who received ultraviolet blood irradiation therapy alone, pain, tenderness and fever when present disappeared within twenty-four to forty-eight hours. Edema disappeared in twelve individuals within three to fifteen days; in the thirteenth, in whom an advanced induration had appeared during fifty days of failure to respond to four nerve blocks, the patient was able to walk for the

* From the Blood Irradiation Clinic, Hahnemann Medical College and Hospital, Philadelphia, Pennsylvania.

first time, but edema and induration were still present at the time of hospital discharge, eight days after a single blood irradiation.

BRIEF ABSTRACTS OF TYPICAL CASE HISTORIES

CASE 1. No. 46943, age forty, a female, was admitted March 18, 1940, for a nephropexy which was done March 20, 1940. For the first two postoperative weeks the patient's convalescence was relatively uneventful, when on the fourteenth postoperative day she began complaining of pain in the left leg localized over the femoral area. A heat cradle was applied and the leg elevated, and within twenty-four hours the pain disappeared. She was allowed out of bed at this time and within a few hours her leg began to swell, temperature rose to 101.8°F. and her pulse to 120. Despite bed rest, hot compresses and 40 gr. of sulfanilamide the patient's temperature and pulse rate remained elevated for the next five days, then descended slowly with a daily peak temperature ranging between 99° and 100°F. At this time, April 15, 1940, a 500 cc. blood transfusion was given. On the following day the patient's temperature rose to 103.2°F., and her symptoms of pain and swelling which had subsided somewhat became greatly aggravated. Sulfapyridine was given (15 gr. every four hours) for forty-eight hours, but was tolerated badly. The patient's temperature continued for three days to be elevated with a daily peak ranging from 99° to 100.4°F. In addition occasional chills were present. Sulfapyridine was stopped April 17, 1940; blood culture taken on this day was negative, but no improvement was noted in the next forty-eight hours, and on April 19, 1940, ultraviolet blood irradiation therapy was instituted (200 cc. of patient's blood was irradiated according to the Knott technic). Within twenty-four hours the patient's temperature fell to normal; within forty-eight hours her pain had disappeared completely and on April 26, 1940, seven days later, swelling had disappeared. The patient convalesced uneventfully, and was discharged from the hospital April 30, 1940, in apparently excellent condition eleven days after a single blood irradiation.

CASE 7. No. 78263, age forty-eight, a female, was admitted to the hospital with a history of nausea, vomiting, and a spreading infection of the right groin during the previous four to five days. The infection apparently originated from an infected varicose ulcer located along the course of the internal saphenous vein. Physical examination revealed a right-sided saphenous and femoral thrombophlebitis, with marked induration of the right ileo-inguinal lymph glands, a spreading erysipeloid lesion extending from the upper ileo-inguinal region down the inner surface of the thigh halfway to the knee. The lesion was discharging an extremely foul smelling serosanguineous fluid from several areas and there was a marked necrosis of adjacent skin areas. Her temperature on admission was 100.8°F., pulse 120. Wassermann and Kahn tests were negative, hemoglobin 11.7, red blood cells 3,950,000, white blood cells 5,000, polymorphonuclears 76 per cent, lymphocytes 24 per cent. The patient was extremely toxic and debilitated. At the end of forty-eight hours her temperature rose to 103.4°F., at which time August 10, 1942, ultraviolet blood irradiation was instituted (290 cc. of patient's blood being irradiated according to the Knott technic). During the first forty-eight hours the patient's toxic symptoms began to subside, the groin lesion broke down in several places, and the foul discharge became more profuse. The patient's temperature remained elevated at 102°F. On the third post-irradiation day the temperature began to drop and the drainage was markedly less. The patient's general condition had improved markedly. On August 15, 1942, the inflammatory process along the course of the saphenous and femoral veins had definitely subsided; pain, tenderness and swelling had disappeared. In the remaining few hospital days a rapid healing of the whole ileo-inguinal skin area occurred and the ileo-inguinal lymph glands, although still palpable, had lost their original induration. The patient convalesced uneventfully, and at the time of discharge on August 21, 1942, eleven days after a single blood irradiation, she was in excellent general condition, and the ileo-inguinal, femoral skin lesion had healed.

CASE 8. No. 70645, age forty-three, a male, was admitted to the hospital October 28, 1941, complaining of severe pain and extensive swelling of the left leg. Physical examination revealed deep, extensive thrombophlebitis of the left leg with marked induration of the edematous tissue which apparently had been present two weeks previous to admission, and

was secondary to a puncture wound of the foot. At the time of admission the patient's temperature, pulse and respiration were normal. Heat was applied and four therapeutic nerve blocks were given on October 30, 1941, November 13, 1941, November 30, 1941 and January 2, 1942. No relief of pain, tenderness or swelling was observed following any one of these blocks, and the patient was unable to bear weight on the thrombophlebitic limb at any time. On January 12, 1942, ultraviolet blood irradiation therapy was given (215 cc. of patient's blood being irradiated according to the Knott technic). Within twelve hours the patient stated that his pain was markedly diminished, and within twenty-four hours said that it had disappeared completely. At the end of forty-eight hours no tenderness could be observed, there was no appreciable reduction in swelling, and the patient was able to balance weight on the swollen limb. He was discharged from the hospital pain free and ambulatory on January 20, 1942, in a relatively improved condition, seven days after a single blood irradiation.

Case 9. No. 71548, age twenty-four, a female, was admitted to the hospital February 6, 1942, and on February 8, 1942, delivered a normal infant. The first four postpartum days were uneventful, and on the fifth postpartum day an acute bilateral femoral phlebitis developed. A heat cradle and hot compresses were applied, and sulfathiazole gr. 45 initially and gr. 15 every six hours was given. After seventy-two hours of this combined therapy had failed to relieve the patient's symptoms of pain, tenderness and swelling, the sulfathiazole was stopped, and on February 16, 1942, the ninth postpartum day, ultraviolet blood irradiation therapy was administered (225 cc. of patient's blood being irradiated according to the Knott technic). Within twelve hours the patient's temperature fell to normal and the pain and tenderness disappeared. Forty-eight hours later no swelling could be observed. The patient was discharged February 21, 1942, five days after ultraviolet blood irradiation.

On returning home the patient began immediately to carry on normal, strenuous household duties, and suffered a recurrence of bilateral thrombophlebitis. She was readmitted to the hospital March 6, 1942, with a recurrence of pain and tenderness of both femoral regions, and a marked edema of both legs; her temperature had remained normal. At this time the patient also complained of dull pain in the right lumbar region. Blood count and urinalysis taken at this time proved normal. Ultraviolet blood irradiation therapy was repeated the day of admission March 6, 1942 (225 cc.). The following day the patient's pain and tenderness seemed much less severe, although the pain in the right lumbar area persisted. The pain, tenderness and swelling subsided completely but slowly during the fourteen days subsequent to irradiation. Her convalescence during this time was uneventful. At the time of discharge March 20, 1942, her condition was apparently good. No further recurrence of phlebitis has been observed.

Case 10. No. 76953, age forty-seven, a female, was admitted June 17, 1942, and prepared for vaginal hysterectomy. On the sixth hospital day, June 23, 1942, a supravaginal hysterectomy, bilateral salpingo-oophorectomy and Schroeder amputation of cervix were performed. On the evening of the day of operation the patient's temperature rose to 101.2°F., pulse to 116. This rise in temperature and pulse rate persisted for three days, the temperature then falling slowly to a level ranging between 99° and 100°F., and her pulse remaining at an approximate 100. On the twelfth postoperative day the patient began complaining of some tenderness of the left leg, femoral area, her temperature rose to 101.8°F., and pulse rate to 120. On the following day her temperature rose to 102°F., and pulse to 128. On the next day, with a marked increase in the pain and tenderness along the course of the femoral vessels in the left leg, plus a moderate amount of edema, a diagnosis of acute septic phlebitis was made at this time July 6, 1942, and the leg was elevated and a heat cradle applied. On the following day July 7, 1942, ultraviolet blood irradiation therapy was given (200 cc. of patient's blood being irradiated according to the Knott technic). Forty-eight hours later the patient stated that her pain was greatly diminished and tenderness over the femoral vessels of the left leg was markedly diminished. The patient's temperature, however, rose to a daily peak at a level between 100° and 101°F. for the next five days, although at the end of this period of time all signs of pain and tenderness had disappeared and edema was barely perceptible. It was believed that the large heat cradle which was being used during severe summer weather might possibly prevent normal dissipation of body heat, so this was removed. On the following day the patient's temperature

dropped to 99°F. The patient convalesced uneventfully from this point on with a morning temperature rise during the next few days to 99.6°F. She was discharged July 25, 1942, eighteen days after a single blood irradiation, in apparently good condition and symptom free.

CASE 12. No. 75417, age eighteen, a female, was admitted June 24, 1942, complaining of

TABLE OF RESULTS OF ULTRAVIOLET BLOOD IRRADIATION THERAPY IN THROMBOPHLEBITIS

No.	Age and Sex	Veins Involved	Type Etiological	Symptoms Present at Time of Initial Blood Irradiation				Results	No. of Uvbit*	No. of Days in Hospital after Initial Uvbit
				Edema	Pain	Tenderness	Fever °F.			
1	40 F	LF	Postoperative (nephropexy)	+	+	+	99–104.4	Disappearance of pain, tenderness, and fever in 24 hrs., of swelling in 7 days.	1	11
2	30 F	LF	Postoperative (appendiceal abscess)	+	+	+	98–100.8	Disappearance of pain, tenderness, fever and swelling in 48 hrs.	2	11
3	33 F	LF	Postoperative	+	+	+	None	Disappearance of swelling, pain, and tenderness in 48–72 hours.	1	14
4	42 F	LF	Postoperative (hysterectomy)	+	+	+	99–101.6	Definite reduction of pain, tenderness, and swelling in 48 hrs., temperature falling to normal. All disappeared in 7 days.	1	7
5	32 F	LF	Postpartum	+	+	+	103.8	All symptoms began to subside in 48 hours.	1	22
6	18 F	LF	Post-Caesarean	None	+	None	102.0 staph-albus septicemia	Leg pain disappeared in 24 hrs., temperature normal after 2nd irradiation.	2	11
7	48 F	RF RS	Postinfections (infected varicose ulcer, erysipeloid skin lesion, lymphadenitis)	+	+	+	103.4	Pain, tenderness, edema disappeared in 5 days; skin infection also subsided in 5 days.	1	11
8	43 M	LF	Postinfectious, wound of foot	+ present 3 months, indurated	+	+	None	In 48 hrs. pain and tenderness subsided, but not edema; able to walk for first time, since onset of pathology.	1	8
9	24 F	LF RF	Postpartum	+	+	+	101–102	Pain, tenderness, swelling and fever disappeared in 12 hrs. Patient readmitted with feverless recurrence which subsided completely in 14 days; no further recurrence.	1 1	5 (recurrence) 14
10	47 F	LF	Postoperative (hysterectomy)	+	+	+	102	Pain, tenderness, and swelling gone in 5 days; temperature fell to normal on 6th post-irradiation day, after removal of heat cradle.	1	18
11	65 M	LF	Postinfectious (severe dental caries)	+	+	+	None	All signs of phlebitis disappeared in 15 days; teeth extracted, renal colic present, in remaining 13 days.	1	28
12	18 F	RS	Postpartum	+	+	+	99.6	Pain, tenderness gone in 10 days; fever and swelling in 72 hours.	1	7
13	32 F	RF LF	Postpartum (also pulmonary embolism)	+	+	+	103.8	Leg and chest pain, tenderness and fever disappeared in 48 hours; swelling in 4 days	1	7

Key LF—left femoral.
RF—right femoral.
RS—right saphenous.
LS—left saphenous.
* Uvbit—ultraviolet blood irradiation therapy.

severe pain and swelling of the right leg, giving a history of an uneventful delivery and puerperium one month previous to admission. Physical examination revealed extreme tenderness along the course of the internal saphenous vein popliteal space, Scarpa's triangle and the right parametrium. Bed rest, elevation of leg and sedation were all given this patient, as well as stilbestrol. Twenty-four hours later the patient's symptoms remained unrelieved, and ultraviolet blood irradiation therapy was instituted (200 cc. of patient's blood was irradiated according to the Knott technic) at 11 A.M., June 29, 1942. At 9 P.M. the same night, the patient stated that her pain had subsided completely, and it was obvious that the swelling, while still present somewhat, had diminished markedly. Her temperature which never exceeded 99.6°F. fell slowly to normal during the next seventy-two hours, and she convalesced uneventfully pain and swelling being completely relieved and temperature normal at time of discharge on July 6, 1942, seven days after a single blood irradiation.

It is interesting to note that case reports Nos. 8, 1 and 9 portray typical failures of nerve block and sulfa drug therapy to retard the progress of acute thrombophlebitis. In Case No. 10, the failure of classical conservative treatment by means of heat and elevation of the extremity is demonstrated. In Case No. 7, we find that ultraviolet blood irradiation therapy alone has been used, with a definitely decreased hospitalization time. This latter, in our opinion, represents ideal treatment for acute thrombophlebitis in that the progress of the diseased process is usually checked by one blood irradiation, although a second one may be occasionally necessary.

CLINICAL OBSERVATIONS

The following clinical observations have been made consistently. These findings are easily duplicated, having been produced thirteen times consecutively. In each patient suffering from acute thrombophlebitis, who received ultraviolet blood irradiation therapy, the various classical symptoms subsided in the following manner:

1. *Pain* was the first to disappear; usually the patient stated it had left sometime in the first twelve hours following ultraviolet blood irradiation therapy. In some instances pain disappeared in two or three hours after blood irradiation. The opposite extreme was noted in individuals in whom pain, though much less severe in twelve hours, persisted mildly for forty-eight to seventy-two hours, the longest period required for the disappearance of pain. This striking and rapid relief of pain was usually appreciated most by the patient.

2. *Tenderness* along the course of the affected vein usually disappeared completely two to six hours after the subsidence of pain. This phenomenon is the first objective evidence of blood irradiation controlling the progress of an acute thrombophlebitis.

3. *Fever*, if present, consistently was found to drop to normal in twenty-four to forty-eight hours. The only exception to this was in individuals in whom abscess formation was also present or occurring, in which event the temperature remained elevated between 99° and 101°F. until the abscess was evacuated.

4. *Edema* was the last symptom to disappear and its disappearance time varied from twenty-four hours to ten days.

5. *Coldness* of the extremity, when present, was said to disappear within twenty-four to forty-eight hours following initial ultraviolet blood irradiation therapy.

6. The fact that a new thrombophlebitis (Case No. 9) occurred after a previous one had subsided and two weeks after a blood irradiation, suggests that blood irradiation exerts no prophylactic protective effect, at least for more than two weeks; the fact that the newly occurring thrombophlebitis, in turn, subsided rapidly after ultraviolet blood irradiation therapy and did not recur, speaks for itself.

THEORETICAL CONSIDERATIONS

The appearance, following ultraviolet blood irradiation therapy, of several of the known biochemical and physiological effects of ultraviolet, notably the bactericidal,

detoxification and vasodilation effects, as well as the increase in venous oxygen values of individuals with abnormally low venous oxygen content, has been reported by Miley,[4] Knott and Hancock,[5] Rebbeck[6,7] and Barrett.[8]

It seems rather unlikely that any of these four effects of ultraviolet, alone or combined, could completely account for the dramatic result observed in the thirteen cases reported. Therefore, it is not improbable that one or more other physiological or biochemical effects must be considered as partially responsible for this profound and rapid change in the status of the patient with acute thrombophlebitis.

In a recent report, Rebbeck and Miley[9] stated they had made the observation that, in patients with peritonitis with advanced and prolonged paralytic or adynamic ileus, a rapid and consistant restoration of gastrointestinal to normal smooth muscle tone and contractility occurred, often twelve to twenty-four hours after a single blood irradiation. This was observable clinically in this short period of time by the expulsion of flatus, disappearance of abdominal distention, the reappearance of normal intestinal motility and the reappearance of normal abdominal auscultatory signs. Such an effect represents a restoration to normal balance of that part of the autonomic nervous system directly controlling smooth muscle tone and contractility of the abdominal portion of the gastrointestinal tract, a part of the autonomic system hopelessly out of balance before the application of ultraviolet blood irradiation therapy.

Continuing along this line of reasoning it is possible, in the light of the clinical effects observed in acute thrombophlebitis following ultraviolet blood irradiation therapy, to draw an analogy and point out that there also obviously occurs a restoration to normal tone and contractility of the smooth muscle elements of that portion of the peripheral vascular system directly affected by the pathology of acute thrombophlebitis. Again we find in turn a marked restoration to normal balance of those automatic fibers innervating those blood vessels affected by the thrombophlebitis, fibers which previous to blood irradiation were in an advanced state of imbalance, as shown by their partial or complete atony.

Whether the effect of irradiated blood is directly on smooth muscle in the instances of paralytic ileus and thrombophlebitis mentioned, whether it is involved with the acetylcholine mechanism directly, whether it is a direct effect on peripheral or postganglionic autonomic fibers or a central effect, it is impossible to say. In view of the lack of evidence, especially in acute thrombophlebitis, of central and generalized autonomic nervous system imbalance, and in view of the purely local type of autonomic imbalance, one would consider a localized peripheral action of irradiated blood on that part of the autonomic system in a state of marked and obvious imbalance a distinct possibility. Against this view is the obvious fact that marked generalized peripheral vasodilation occurs with almost monotonous frequency following blood irradiation, that frogs irradiated externally with ultraviolet show vasodilation not only of the cutaneous capillaries but also of the capillaries of the large viscera; both of these effects are possibly due to direct stimulation of the medullary vasomotor centers, of preganglionic parasympathetic fibers, or to a diffuse, generalized postganglionic stimulation, and are not necessarily associated with a previously existing breakdown of autonomic nervous system control.

It is interesting to observe that the grossly discernible vasodilation effects noticed following application of ultraviolet blood irradiation therapy occurs in apparently normal humans, as well as in those who are suffering from various disease processes, whereas an increase in tone of normal gastrointestinal smooth muscle is not apparent, at least not to the extent that it produces colicky or cramp-like contractions. Likewise, as just stated, no evidence of an increase in smooth muscle tone, as in acute thrombophlebitis with edema, appears in normal individuals following blood

irradiation, but, on the contrary, only vasodilation. Therefore, it must be assumed that there exists a profound and fundamental regulating effect of irradiated blood upon the autonomic nervous system; this effect could be described as a "normalizing" effect and becomes most apparent in definite imbalance of the autonomic system.

In any event, there exists a close relationship between ultraviolet blood irradiation therapy on one hand and the restoration to normal of an autonomic regulatory mechanism hopelessly out of balance secondary to such pathological processes as found in paralytic ileus and acute thrombophlebitis. That this effect represents a subtle mechanism of an enzymatic or catalytic motive, is theoretically possible and suggests itself. A more simple theoretical explanation would be that individuals who respond to ultraviolet blood irradiation therapy so obviously, may be suffering from ultraviolet deprivation brought about by a breakdown, secondary to various disease processes, of the body's mechanism for absorbing ultraviolet, by an inadequate supply of ultraviolet, or by a combination of both.

Again we wish to emphasize that ultraviolet blood irradiation therapy produces some known and probably many unknown biochemical and physiological effects of ultraviolet energy and is not specific treatment for any disease. However, it is equally true that those disease processes which can be benefitted by the production of the aforementioned effects of ultraviolet energy probably will be controlled efficiently by ultraviolet blood irradiation therapy.

SUMMARY

1. In thirteen consecutive instances, individuals with acute thrombophlebitis were given ultraviolet blood irradiation therapy.

2. In all thirteen, a rapid disappearance of pain and tenderness was observed, usually within twenty-four to forty-eight hours following a single blood irradiation.

3. A drop to normal of abnormally high temperatures, when present, was found to occur within forty-eight to seventy-two hours.

4. Edema subsided completely in twelve of the thirteen cases, the disappearance time varying from thirteen to fifteen days. In the thirteenth case, a marked induration was associated with edema and neither had disappeared when the patient left the hospital on the eighth postirradiation day.

5. A complete absence of untoward effects in all patients treated was evident.

6. Of the thirteen cases, five were good examples of the failure of sulfa drugs plus local heat, bedrest, and elevation of the affected extremity to control thrombophlebitis; four received only ultraviolet blood irradiation therapy and bedrest; three had failed to respond to local heat, bedrest, and elevation of the affected extremity; and one represented the absence of any effect, in fifty days, of four therapeutic nerve blocks to influence the disease process; an apparent permanent indurative damage had occurred.

CONCLUSION

1. A new phenomenon, the relatively rapid disappearance of the classical signs of thrombophlebitis following ultraviolet blood irradiation therapy, has become apparent.

2. The excellent results observed in the thirteen consecutive cases reported warrants the further clinical application of ultraviolet blood irradiation therapy in individuals suffering from acute thrombophlebitis.

REFERENCES

1. Miley, G. *Am. J. Surg.*, 57: 493, 1942.
2. Miley, G. *Arch. Phy. Therapy*, 23: 536, 1942.
3. Miley, G. *Hahnemann Monthly*, 75: 977, 1940.
4. Miley, G. *Am. J. Med. Sc.*, 197: 873, 1939.
5. Knott, E. K. and Hancock, V. K. *Northwest Med.*, 33: 200, 1934.
6. Rebbeck, E. W. *Am. J. Surg.*, 54: 691, 1941.
7. Rebbeck, E. W. *Am. J. Surg.*, 55: 476, 1942.
8. Barrett, H. A. *Med. Clin. North America*, 24: 723, 1940.
9. Rebbeck, E. W. and Miley, G. *Rev. Gastroenterol.*, Jan.–Feb., 1943.

TOBACCO SMOKING AND CANCER OF THE LUNG

EDWIN J. GRACE, M.D.
Diplomate of the American Board of Surgery
BROOKLYN, NEW YORK

THE average clinician is slow in appreciating and applying, in clinical practice, the great advances made during the last half century in the basic sciences of chemistry, physics and biology. This approach becomes most important when we consider the increasing number of cancer cases which involve the respiratory tract, and examine, at the same time, the possible bearing which excessive smoking may have on this pathologic condition.

A comprehensive review of the literature on this subject has brought to light many interesting reports, but the experimental studies of Roffo,[1] conducted in Buenos Aires, demand, in my opinion, some comment, because of the great influence they might have upon an important phase of medical science, namely, that of preventive medicine.

After having had an opportunity to observe, over a period of ten years, an unusually large series of patients with cancer of the lung, in two of the large municipal hospitals in New York City, two very distinct elements were noted in these patients: First, the patients were almost always men; second, they were heavy cigarette smokers and almost always inhalers. There is no experimental proof at hand to demonstrate that the smoking of many cigarettes was the cause of lung cancer, however, some aspects of this problem should be carefully evaluated.

Roffo has shown, what seems extremely logical to me, namely, that a carcinogenic compound (benzpyrene) can be isolated from tobacco tar. This investigator has studied the action of tar, particularly tobacco tar, upon the human organism. He found that the latter is more active and malignant than coal tar, and that 95 per cent of all cancers of the lung, larynx and pharynx occur in smokers. Mortality among smoking patients afflicted with cancer mounted from 148, in 1926, to 513, in 1937. These observations and chemical investigations indicated that the carcinogenic agent is not contained in the nicotine but is a component of the products of combustion of tobacco while smoking. He finally isolated the actual carcinogenic component (benzpyrene) from tobacco tar by fractional distillation at a temperature of more than 380°c. Experiments with this substance revealed that it is highly carcinogenic, and causes invasive, expanding and destructive proliferations. The primary lesions appear earlier than those caused by the use of total tobacco tar. On the basis of these observations, Roffo concludes that tobacco benzpyrene is responsible for the carcinogenic action found in tobacco tar.

It is obvious, therefore, that this product of combustion deeply inhaled into the lungs of cigarette smokers—for cigarette smokers usually inhale—is deposited in the lung along the entire bronchial system, and most of the biologic principles are present, I believe, to produce bronchogenic carcinoma in accordance with well known animal experiments.

The three cases which were studied at this Clinic were all heavy smokers, and all had inhaled over a period of at least fifteen years. All three had a very active and inoperable cancer, with metastases, and died as a result of this disease.

CASE REPORTS

CASE 1. W. D., a male, age forty, came to the Clinic, March 24, 1937, with a history of numerous head colds, developing during short intervals, combined with sore throat, and followed by a dry, hacking cough. There was a small amount of thick, blood-streaked sputum.

This patient had been gassed during World War I, and at that time had been ill for four months. His father had died of a brain tumor.

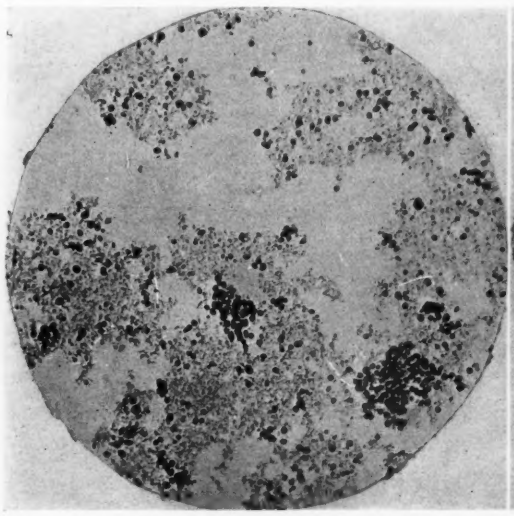


FIG. 1. Case I. Microphotograph taken at operation.

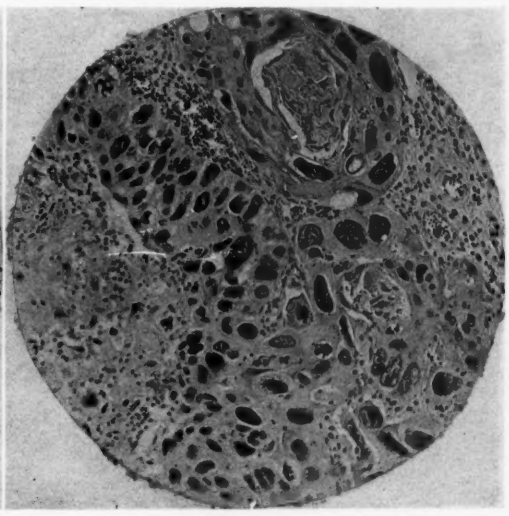


FIG. 2. Case II. Microphotograph taken at operation.

The patient had been losing weight. There was no fever or night sweats and no chest pain. Sinus trouble had been present for some time, and it became worse on March 26, 1937. Roentgenograms taken shortly before this time revealed a possible tuberculous lesion at both apices, which was of minimal extent, of fibrotic appearance, and apparently arrested. However, a mass-like infiltration was noted extending from the upper part of the left cardiac border into the first and second left intercostal spaces. No tubercle bacilli were demonstrable. Fluoroscopy of the esophagus showed that the latter was pushed over to the right of the level of the pulmonary lesion.

On September 14, 1937, exploration of the left thoracic cavity was made by an anterior approach between the second and third ribs. The upper mediastinal area was entered and a tumor mass found which was fixed and obviously inoperable. The tumor occupied the entire three-fourths of the upper part of this cavity, and was confluent with an adherent mass in the upper left lobe. In view of the inoperability of the tumor, fifteen seeds of radium emanation were implanted into the mediastinum. There was no gross evidence of metastases on the surface of the left lung, but the primary tumor was probably in the periphery of the left upper lobe.

A biopsy of the mediastinal mass was taken and, microscopically, it was a Grade IV tumor, probably a bronchogenic metastasis.

The general condition seemed fair during repeated check-ups, the radon seeds having apparently helped the mediastinal obstruction. In August, 1938, he complained of pain in the left forearm, with numbness in the fifth finger. His cough was becoming worse, and was accompanied by nausea and vomiting. He subsequently developed a classical Horner's syndrome. The patient continued to lose weight, and all symptoms grew progressively worse. Death ensued shortly afterward.

CASE II. F. R. P., a male, age fifty-four, reported to the Clinic, in March, 1940, with a history of having had a slight cough for two or three years. During the past three months there had been some pain in the left shoulder, radiating to the hand. The patient was losing weight and had moderate hemoptyses. Roentgenograms, taken elsewhere, showed marked infiltration in the left upper lobe, with a large cavity just below the level of the clavicle, strongly suggestive of pulmonary tuberculosis. One positive sputum was obtained. The best method of treating the condition appeared to be an upper-stage thorocoplasty. At operation, there was found, between the third and fourth ribs, a protrusion about the size of a small egg, grossly, suggestive of a neoplasm.

Pathologic examination revealed bronchogenic carcinoma, Grade II. No tuberculosis was found at any time in the many tissues involved.

Shortly before his death a classical Horner's syndrome developed, probably as a result of the spreading neoplasm. The patient died three months postoperatively.

Case III. A. H., a male, age thirty-nine, complained of pain in the chest, chronic cough, and loss of weight during the six months preceding his visit to the Clinic (October, 1941). Roentgenograms revealed atelectasis and fluid in the left side. Bronchoscopic examination demonstrated a neoplasm involving the left main bronchus. Operative exploration was undertaken through an anterior approach. Adhesions were found throughout most of the pleural space, which were unusually dense over the left lower lobe, where they were firmly adherent to the chest wall and diaphragm with numerous metastatic implants. Surgical removal was not possible.

A biopsy of the lung showed bronchogenic carcinoma, Grade III.

The patient died, January 2, 1942, with generalized metastases involving the pericardium, pleura, pancreas and stomach, with the primary site in the left lung.

I believe the three cases discussed here bear out the theory of Roffo, that possibly the carcinogenic irritants from tobacco tar are deposited in the lung, and the end result of this irritation, in a biologically susceptible individual, is the production of a bronchogenic carcinoma.

In spite of all the technical improvements of dealing with cancer, we, at present, cannot successfully cope with high grade neoplasms of the lung, and the low grade tumors which give a better prognosis surgically, represent a badly handicapped group of individuals.

In attempting to analyze these cases of cancer of the lung using tobacco smoking as the causative agent, we note data that might be productive of important preventative measures. Cramer, in discussing the many causes of cancer, and from experimental evidence at present available, when applied to man, established four distinct groups: (1) Carcinogenic agents, (2) precancerous conditions, (3) susceptibility, and (4) time factor.

In applying Cramer's grouping to the three cases herewith reported, in Group I (carcinogenic agents), we find a very potent carcinogenic compound (Benzpyrene) in the tar of smoking tobacco that all these patients deposited in their lungs.

Fig. 3. Case III. Microphotograph taken at operation.

Regarding Group II (precancerous conditions), Dr. Cramer reports that "during the prolonged period of induction necessary for a carcinogenic agent to elicit cancer, the tissue on which these agents act undergoes a pathologic change, and it is in this altered tissue that eventually a malignant condition develops in a sharply circumscribed area." We believe that in our three cases this etiologic factor was probably produced by tissue alteration from the constant inhalation of the tar with its carcinogenic agent.

Group III (susceptibility) cannot be directly applied to any of these cases with certainty, except possibly in Case I, where the history states that his father died from brain tumor. However, the mere fact that a tumor did develop shows that some degree of susceptibility may have existed, which might have been stimulated by a

carcinogenic agent. In genetically susceptible individuals. In spite of these apparent imponderables, in attempting to establish scientific facts, Cramer states: "The relationship between the two factors susceptibility and carcinogenic agent can be expressed crudely by a simple equation of two variables *A* and *S*, and a constant, *C*: $A \times S = C$. In such an equation the one variable increases as the other diminishes. If *A* represents the carcinogenic agents, *S* the susceptibility, and the constant *C* the carcinogenic effect, the equation expresses the fact that cancer can arise in an organism either with a high susceptibility and a weak carcinogenic stimulus or with a low susceptibility and a strong carcinogenic stimulus. The equation reads therefore: Carcinogenic agent × susceptibility = carcinogenic effect." It is believed that the three cases reported partly fulfill these requirements.

In Group IV (time factor) all these cases more than fulfill this time requirement. Their ages being forty, fifty-four and fifty-nine, respectively, the period of smoking with the induction of tar, with its carcinogenic compound, into the lung was a minimum of twenty years. The significance of this time factor is obvious because "the production of cancer by coal tar requires on the average six months in a mouse and fifteen years in a man. With a life span of two years for a mouse and seventy years for a man, six mouse-months represent one-fourth of the life span of a man. During this long period of induction the tissue on which the carcinogen acts undergoes a series of pathologic changes involving among other things increased cell division. Eventually this altered tissue passes into a condition in which a few cells within this altered tissue undergo, sooner or later, an irreversible intracellular change which transforms them into malignant cells. When this happens the scene changes from the exterior to the interior of the cell."

CONCLUSIONS

In three proved cases of cancer of the lung, it would seem logical to assume that possibly in some biologically susceptible individuals, the carcinogenic agent in the tar of smoking tobacco might be the causative factor. Using clinical data, and coordinating it with studies in the basic science of chemistry and biology, further evidence is suggested to confirm our opinion that the gravity of this habit of smoking should be clinically emphasized.

REFERENCES

1. Roffo, A. H. Correlation between carcinogenic action of tobacco tar and coal tar. *Prensa méd. argent.*, 28: 1003, 1941.
2. Cramer, W. The origin of cancer in many. *J. A. M. A.*, 119: 309, 1942.

THE VALUE OF AUSCULTATION OF THE ABDOMEN IN THE DIAGNOSIS OF ACUTE APPENDICITIS

N. C. STEVENS, M.D.
Associate Attending Physician, Elliot Community Hospital, Keene, New Hampshire
WALPOLE, NEW HAMPSHIRE

THE cardinal symptoms and physical signs of acute appendicitis are so well known it is not necessary to discuss them in this article. The writer will confine himself to the discussion of the value of auscultation of the abdomen in the diagnosis of acute appendicitis. So little attention has been paid to the significance of the peristaltic rate in its relation to some functional and organic conditions of the abdomen, it might be well to state what the normal rate is and its variations in functional disturbances and organic diseases.

The peristaltic rate in a healthy young adult varies between five and ten tinkles a minute. After a meal there may be a slight increase in the rate. The tinkles are high pitched and faint in character. They resemble the sound of water dropping into a well from a height. The rate is influenced by the condition of the nervous system, indiscretions of diet, alcohol and by certain organic conditions such as acute appendicitis, perforated gastric ulcer and intestinal obstruction. It is influenced by diseased conditions in other parts of the body, by high temperature, and by certain drugs. This article is concerned with the effect of inflammation of the appendix upon the peristaltic rate.

At the beginning of an attack of acute appendicitis the peristaltic rate is increased. At this stage the inflammation acts as an irritant with stimulation of the autonomic nerve endings and an increase in the rate. As the inflammation proceeds and the outer coat of the appendix becomes involved peristalsis diminishes. When the peritoneum becomes involved by a leakage of exudate, peristalsis ceases altogether and the abdomen becomes silent. Cessation of peristalsis seems to depend upon infection or irritation of the peritoneum. In cases of retrocecal appendicitis with the appendix lying outside of the peritoneum the peristaltic rate is apt to be accelerated and has a characteristic muffled sound, faint and distinct, which can be best discribed as "scratchy." After rupture of an appendix with the exception of retrocecal appendicitis, the abdomen remains silent until extension of peritonitis ceases and inflammation becomes localized. Then peristalsis begins again. After rupture of an appendix the abdomen may remain silent from twenty-four to forty-eight hours.

If the peritonitis becomes localized and an abscess forms in the right lower quadrant, partial obstruction may occur which stimulates the peristaltic rate to overcome the obstruction.

There is a large group of cases characterized by right lower quadrant pain, tenderness, spasm, a rise in temperature and pulse rate and possibly a slight increase in the blood count as well as nausea and vomiting that are not due to inflammation of the appendix. All the cardinal signs and symptoms can be simulated by a spastic cecum and a collection of gas in the right lower quadrant. Fortunately, in this condition peristalsis is usually hyperactive and may be continuous which is the reverse of that which occurs in acute appendicitis. As a rule symptoms subside very quickly after an enema, or a hypodermic injection of sodium luminal.

A great many of these patients are operated upon and a normal appendix is removed at operation. A word of caution must be added here. Not all silent abdomens are due to peritonitis. In some cases of

acute indigestion due to indiscretions of diet, alcohol, extreme fatigue or nervous tension there is spasm at the pylorus which seems to effect the motility of the entire gut. In this condition no sounds are heard over a considerable period, which with the associated pain and occasional nausea and vomiting, might lead one into the error of believing that a surgical condition exists. A large dose of sodium luminal given hypodermically will relieve this condition in a short time. Usually within twenty five minutes after the injection peristalsis begins, the pylorus opens and gas and stomach contents begin to pass along; at this point the pain and discomfort usually disappear.

Attacks of periodic vomiting, especially in children, are quite common. The vomiting may be associated with pain but usually is not. The vomiting may continue for hours and even days. In these cases there is also spasm at the pylorus and the abdomen may be silent for long periods of time.

CASE REPORTS

Case I. On December 21st, a garage man, aged thirty-two, began to have pain in his abdomen. At the beginning the pain was cramp-like in character, worse after eating. Next day the pain was general and was worse than the preceding day. He felt nauseated, but did not vomit. In the evening he had a temperature of 99°F. A physician was called who made the diagnosis of intestinal grippe and advised a cathartic and enema. The result from the enema was not satisfactory. The following day, December 24th, the patient was much worse. The pain had localized in the right lower quadrant and his abdomen was distended. He had had no movement of the bowels and an enema was unsuccessful. The next day I was called in to see him. He appeared acutely ill, his face was flushed, his tongue coated and dry. His abdomen was considerably distended, there was tenderness over the entire abdomen, but most marked over the right lower quadrant. There was rigidity in the right lower quadrant. On auscultation peristalsis was entirely absent. His blood count was 18,000, with 85 per cent polymorphonuclears.

The patient had been operated upon for appendicitis several years ago, and an inflammed appendix was said to have been removed. It was evident that the patient had an acute condition of the abdomen, but due to the fact that an appendectomy had been performed I thought the most probable condition was intestinal obstruction. His immediate removal to the hospital was advised. A consultant was called who advised an immediate operation. At operation an abscess was found in the right lower quadrant resulting from a gangerous stump of the appendix which had not wholly been removed at the previous operation. The abscess was more or less walled off, but there was a considerable area of the peritoneum involved. He had a very stormy time for three days following the operation and it was thought he could not survive. However, after the third day he began to improve and made an uneventful recovery.

For auscultation to be of any value it is necessary to listen at invervals over a period of time, from one-half to three-quarters of an hour. Peristalsis may be absent at one examination, but not at another.

Case II. A laborer, fifty-two years old, began to have pain in his abdomen on the evening of November 21st. The pain was intermittently severe, first general and then becoming more intense in the right lower quadrant. He vomited several times during the night and the day following. His bowels had not moved for two days. On November 23rd, he called a doctor for the first time. His temperature was 99.5°F. There was tenderness and rigidity in the right lower quadrant and marked tenderness on rectal examination.

The same evening I saw the patient in consultation. The temperature was then normal and the tenderness and rigidity had diminished somewhat. On auscultation of the abdomen the peristalsis was loud and continuous. My advice was to give the patient an enema and to wait.

The next morning the pain had disappeared; there was no tenderness or rigidity, only a slight soreness remaining. The peristaltic rate was almost normal. Following the enema the patient had had a large evacuation. The following day he left the hospital.

There are a large group of cases characterized by right lower quadrant pain and tenderness that simulate acute appendicitis very closely. This is due to either constipation, indigestion, or to a spastic cecum, a condition very common in nervous people. Gas collects behind the spastic segment, and very severe pain may ensue.

Recently I saw a case that simulated the picture of the perfect textbook case of acute appendicitis. A boy eight years old began to have pain in the abdomen about 9 A.M. During the morning he vomited several times. About 4 P.M. the pain shifted to the right lower quadrant. His mother became alarmed and called me in to see him. On physical examination the face was flushed, the tongue coated, the temperature 99½°F., pulse 90. The tenderness was marked in both lower quadrants, more so on the right. Peristalsis was intermittently very active, loud gurgling sounds followed by silent intervals. An enema was given which brought away a considerable amount of flatus and hard fecal matter. Inside of half an hour the child was perfectly comfortable, and the peristalsis was diminished.

A large percentage of these patients are operated upon and a normal appendix is removed. Nearly all the cardinal signs of acute appendicitis may be present: pain and tenderness in the right lower quadrant, nausea or vomiting, a slight elevation of temperature. In one case I saw, there was even a rise in the blood count to 15,000. However, in these cases the peristaltic rate is usually increased, and may be continuous. Very often the abdomen becomes so noisy that the patient himself is conscious of it. I have yet to see a case of acute appendicitis approaching rupture with a noisy abdomen. As a rule the symptoms subside very quickly after an enema. A hypodermic of sodium luminal is useful in relieving the spasm.

Case III. A boy, aged twelve, complained of pain in his abdomen at noon. The pain increased in severity during the afternoon. It was localized mostly in the epigastrium. He vomited several times.

At 6 P.M. I was called in to see him. He looked rather acutely ill. The tongue was not coated; throat and chest were normal. There was a slight fullness to the abdomen. The tenderness was general, probably more in the right lower quadrant than elsewhere. There was no rigidity. On listening to the abdomen over a period of fifteen minutes no peristaltic sounds were heard. The temperature was 99.5°F. and the pulse rate 95. The white blood count was 18,000 with 90 per cent polymorphonuclears.

His immediate removal to the hospital was advised. Just before operation the abdomen was still silent.

At operation a swollen, moderately congested appendix was found directly beneath the incision on the peritoneum. It was lying free and almost touching the peritoneum, so no handling of the intestine was necessary. The appendix was covered with fibrin. It was removed without difficulty. In all probability it was several hours away from rupture.

This patient was operated upon eight hours after the onset of symptoms. The abdomen was silent at the end of six hours. Peristalsis may have been absent for sometime previous to my visit. Peristalsis stopped early because the appendix was lying free and close to the peritoneum.

A good rule in suspected cases of acute appendicitis is that with increasing pain in the right lower quadrant and decreasing peristalsis the chances of an inflamed appendix are strong.

Case IV. On May 11th, at 4 P.M. a lady, age thirty-five, came to my office complaining of pain in the right lower quadrant. She said that for the past ten days she had had cramp-like pains in her abdomen, that they had been general up to the day she had come to see me, and that during the last twenty-four hours had localized in the right lower quadrant. She had been up and around and able to do her work, and had worked all day up to the time she came to see me. She had not vomited nor had she been nauseated. She had lost eight pounds in the last ten days. Her temperature was 99°F. On examination the abdomen was soft except in the right lower quadrant where there was rigidity and extreme tenderness. A mass was felt which could be rolled under the fingers and gave the impression of a distended loop of gut. A rectal examination was entirely negative. The white blood count was 12,000 with 80 per

cent polymorphonuclears. Listening at intervals over a period of three-quarters of an hour, I heard no peristaltic sounds whatever.

I told her that I thought she had a ruptured appendix and should be in the hospital. She expressed considerable surprise at the diagnosis and did not like the idea of going to a hospital. She did not agree with my diagnosis, as she did not see how it was possible to have a ruptured appendix and be able to walk around and keep at her work. She went home undecided what she would do. Later in the evening her employer called me and asked for a consultation. The next morning a surgeon called to look at her. She was feeling much better, had very little pain, her temperature was normal, the mass which I had felt the afternoon before had disappeared, there was practically no rigidity and very little tenderness. The surgeon did not think she had an appendix and advised her to get up and go about her work.

I did not see her again that day, but went to see her the next morning, May 13th. She was not feeling very well. She complained of cramp-like pains in her right lower quadrant. She had had a chill which lasted for fifteen minutes the night before and had vomited once. On examination there was again some rigidity in the right lower quadrant and a moderate amount of tenderness. A definite tender mass could be felt easily. The blood count was 14,000 with 85 per cent polymorphonuclears. Peristalsis was audible at this time as it had been the previous morning when the surgeon examined her. I reported the results of my examination to the surgeon and he advised her immediate entrance to the hospital.

At operation upon opening the peritoneum there was a moderate amount of free fluid. The appendix was very large, red and adherent to the cecum and lateral abdominal wall. The omentum had almost completely encircled it except where it touched the peritoneum. At this point of contact it had ruptured and was gangrenous.

When I first saw this patient the appendix either had ruptured or was on the point of rupturing. The next morning she was feeling better with practically no pain. Peristalsis which had been absent the afternoon before was infrequently audible which meant that the abscess was walled off and extension of peritonitis had ceased. The return of her symptoms on the third day was probably due to increase in size of the abscess and absorption of pus.

Case v. A laborer, age twenty-two, while eating supper on the evening of November 25th, began to have severe generalized abdominal pain. Toward the middle of the night the pain became so severe he called a doctor. About this time the pain had localized in the right lower quadrant. On examination there was tenderness in both lower quadrants and most marked in the midline below the umbilicus. The abdomen was soft and there was no rigidity. At that time the doctor was doubtful whether there was any surgical condition. During the night the patient vomited several times. His temperature was 99°F. The pain persisted all night and the next day, but it was not so severe as to prevent him from sleeping at intervals. I was asked to see him in consultation in the afternoon about 3 P.M.

He complained of moderately severe pain. The temperature was 99.5°F. He had not vomited for over twelve hours. He had taken a cathartic the night before and his bowels had moved well in the morning. The abdomen was fairly soft; there was no rigidity, but a slight fullness in the middle line below the umbilicus. Tenderness was marked in both lower quadrants. The peristaltic rate was increased, but muffled and faint in character. The patient was sent to the hospital for observation. I saw him again in consultation at 9 P.M. the same day. In the meantime he had been given an enema which had not relieved the pain. The physical signs were the same as at the previous examination, except the abdomen was entirely silent. Listening at intervals over a period of twenty minutes revealed no sounds whatever. Operation was advised and performed at 10:30 P.M. A large, inflamed appendix about the size of the middle finger was found. It was pointing toward the middle line.

This patient was operated on twenty-seven hours after his pain began. Peristalsis was heard at 3 P.M. It ceased somewhere between 3 and 9 P.M. The appendix had not ruptured at the time of operation. From its appearance it might not have ruptured for another four or five hours.

Case vi. A fourteen year old boarding school girl began to have abdominal pain during the morning of January 4th. The pain was fairly general, and during the morning and afternoon it was especially severe. During the evening the pain increased in severity and

became localized in the right lower quadrant. She was slightly nauseated but had not vomited. A surgeon was called who made a diagnosis of acute appendicitis, and advised her removal to the hospital.

Her temperature upon arrival was 99.6°F., pulse 100, white blood cells 9,000, polymorphonuclears 78 per cent, urine examination negative. On physical examination there was tenderness over McBurney's point and a suggestion of rigidity. On rectal examination there was marked tenderness in the right pelvic region.

The attending surgeon called up the child's parents and advised an immediate operation. The parents requested that another surgeon and myself be called in consultation before the operation was performed. On our arrival at the hospital three hours later, the symptoms and physical signs were unchanged, except that the white cells count had dropped from 9,000 to 7,000, and the polymorphonuclears from 78 to 75 per cent. On auscultation of the abdomen peristalsis was active and loud.

The surgeon who had been called in consultation did not think an immediate operation was necessary and advised keeping the child under observation at the hospital for a day or two. One of us was of the opinion she did not have acute appendicitis, that the pain and tenderness was due to gas and spasm in the cecum, and that an enema was indicated.

Shortly after arrival at the hospital she had another attack of pain, and there was some tenderness and spasm in the right lower quadrant. Her temperature was 99.5°F. and the blood count rose to 15,000. Peristalsis was active. The surgeon was quite sure that she had an acute appendicitis and gave orders that she be prepared for operation. I still was not convinced that she had an acute appendicitis and suggested that she be given an enema before she went to the operating room. This was done and a good deal of hard fecal material came away with the enema. A few minutes later the pain disappeared and she felt perfectly comfortable. Two hours later the temperature and blood count had returned to normal.

The attack occurred three years ago. She has had no trouble since that time.

This girl presented all the cardinal signs of acute appendicitis, pain, tenderness and slight rigidity in the right lower quadrant, a slight rise in temperature and a blood count of 15,000. However, peristalsis was active from the beginning to the end of the attack which is not characteristic of acute appendicitis. At the beginning of an attack peristalsis is usually increased, but as the inflammation progresses, peristalsis diminishes and ceases altogether when the outer coat of the appendix becomes involved.

Case VII. A college student, twenty-one years of age, was awakened by severe pain in the epigastrium at 4 A.M. Between then and 7 A.M. he vomited several times. He refused breakfast. He walked one mile from his room to the campus. There was no letup in the pain. The pain was so severe that he decided to go to the infirmary instead of to his classes. By this time it was beginning to localize in the right lower quadrant.

On physical examination his temperature was 99.5°F., pulse 85, white blood count 25,000, polymorphonuclears 85 per cent. There was tenderness and moderate rigidity in the right lower qudrant. At 9:30 A.M. the attending physician noted active peristalsis. At 11 A.M. another physician listened to his abdomen and made a note that there was only an occasional gurgle. At 11:45 A.M. the abdomen was silent.

He was operated upon at noon. The appendix was lying free and was exposed without difficulty. It was swollen and congested. The tip was darker in color and looked as if it might soon be gangrenous. It was probably two or three hours away from rupture.

There was a period of eight hours from onset of pain to the time of operation. Peristalsis was active at 9:30 A.M., considerably decreased at 11 A.M. and entirely absent at 11:45 A.M.

CONCLUSIONS

1. Auscultation is a valuable supplement to the symptoms, physical signs and blood count in arriving at a diagnosis of acute appendicitis.

2. At the beginning of an attack of acute appendicitis, the peristaltic rate is usually increased. As the inflammation progresses, peristalsis diminishes. When the outer coat of the appendix becomes involved, peristalsis ceases altogether and the abdomen becomes silent. Conversely the writer has

never seen a case of acute appendicitis at or near the time of rupture with a noisy abdomen.

3. Cessation of peristalsis seems to depend upon infection or irritation of the peritoneum. In cases of retrocecal appendicitis, peristalsis does not cease entirely but becomes faint and muffled, which can best be described as "scratchy."

4. Not all silent abdomens are due to peritonitis. In some cases of acute indigestion there is spasm of the pylorus which seems to effect the motility of the gut. In this condition no sounds are heard over a considerable period.

REFERENCES

King, J. E. Postoperative abdominal auscultation. *Am. J. Obst. & Gynec.*, February, 1930.

Stevens, Neil C. Auscultation of the abdomen in the diagnosis of hypermotility. *New York State J. Med.*, July, 1931.

James, T. G. The value of auscultation of the acute abdomen. *Practioner*, no. 790, April, 1934.

Stevens, N. C. Auscultation of the abdomen an aid to diagnosis. *New England J. Med.*, July 19, 1934.

Stevens, N. C. Auscultation of the abdomen. *New England J. Med.*, July 2, 1936.

Vaughan, R. T. and Thorek, P. Abdominal auscultation. *Am. J. Surg.*, August, 1939.

McSwain, Barton. Auscultation in the diagnosis of surgical diseases of the abdomen. *J. Tennessee State Med. Asso.*, November, 1939.

Stevens, N. C. The value of auscultation of the abdomen in intestinal obstruction. *New England J. Med.*, January 15, 1942.

Pelvic inflammation brings about menorrhagia through hyperemia (in the acute stages), congestion (in the chronic stages), and fibrosis.

EXPERIMENTAL OSTEOMYELITIS*

LOUIS SCHEMAN, M.D.,†

PHILIP LEWIN, M.D.,†
Associate Professor of Bone and Joint Surgery, Northwestern University Medical School

SIDNEY SIDEMAN, M.D.†
Associate in Orthopedics, Michael Reese and Cook County Hospitals

AND

MARTHA JANOTA, M.S.
Research Assistant in Bacteriology, Michael Reese Hospital

CHICAGO, ILLINOIS

THE results of experiments through which osteomyelitis was reproduced by us in animals are discussed in the present paper. The thesis is easy to understand; the experiments are easily repeated and the report offers incentive for further experimentation. The technic used in the production of hematogenous osteomyelitis was set forth in a preliminary report.‡

At that time only young rabbits were used; since then older rabbits and dogs have been utilized. In practically every instance the method has been successful in producing osteomyelitis in the tibia selected. Staphylococcus aureus, originally cultured from a child with hematogenous osteomyelitis, was used without attenuation. The organism as taken from the agar medium, is diluted before injection.

The rabbits receive a preliminary immunizing dose. One week later sodium morrhuate is injected into the metaphysis of the tibia. A half hour later the organism is injected into the metaphysis of the same tibia and osteomyelitis develops. Some animals are given the organism intravenously and the osteomyelitis develops only in the tibia which had the morrhuate injection. Without the preliminary immunizing dose, most of the rabbits die from the disease. In dogs, however, osteomyelitis can be produced and the animals kept living without the immunizing dose.

The lesion resulting is a pan-osteitis rather than a localized bone abscess. It is a phlegmonous process involving all the elements of the bone, and resembles the disease as it occurs in man. The basic principle operating in the development of a true osteomyelitis is a suitable preparation of the bone. In the experiments here reported this preparation was accomplished by the intrametaphyseal injection of sodium morrhuate.

Under the microscope morrhuate may be noticed as producing bone necrosis, particularly in the region of the osteid columns. It almost always brings about considerable endosteal reaction, and the inner shaft-trabeculae show evidence of necrosis. We have never seen any evidence of vascular thrombosis. All of the small vessels visualized in morrhuate-control bones are patent. When in direct contact with bone elements, the morrhuate obviously exerts a localized toxic action to be expected, since the marrow spaces have no anatomic communication with the blood vessels. Our injections were made into the metaphysis and hence into the marrow spaces.

The morrhuate does just damage enough so the bacteria are enabled to produce osteomyelitis. In other words, our use of the morrhuate supplied the unknown

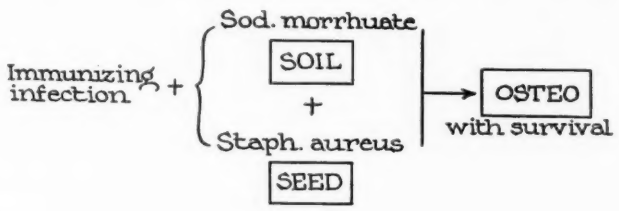
‡ J. A. M. A., 117:1525, 1941.

* From the Department of Orthopedic Surgery, Bacteriology, Pathology and Roentgenology of the Michael Reese Hospital, Chicago. This work was made possible by two grants from the Merriel Abbott and Lilly Marks Funds for Crippled Children. Read before the Meeting of the American Academy of Orthopedic Surgeons, Atlantic City, New Jersey, January 12, 1942.

† Drs. Scheman, Lewin and Sideman are now on active duty in the service of the U. S. Dr. Scheman is a Captain; Dr. Lewin is a Lieut. Colonel, and Dr. Sideman is a Lieut. Commander.

factor by providing the soil. Trauma or embolism may do it in man.

Formerly, osteomyelitis in man was intrametaphyseal injection of staphylococci, whether virulent or attenuated, will result in a true osteomyelitis.



1st WEEK	2nd WEEK	3rd WEEK	4th WEEK
Sod. morrhuate Staph. aureus injected into metaphysis	Osteo	30% survival	No survivals
Sod. morrhuate injected into metaphysis Stap. aureus injected intravenously	Osteo	40% survival	No survivals
Immunizing subQ injection Staph. aureus	Sod. morrhuate Staph. aureus injected into metaphysis	Osteo 90% survival	Animals sacrificed

Fig. 1. Scheme outlining method for the experimental production of osteomyelitis.

thought due to vascular thrombosis and infection. Morrhuate was selected as the thrombotic agent, the belief that it acted in this manner lasting until observed necrosis of the bone convincingly annulled it. The evidently direct action of the morrhuate on the osteoid columns and endosteal bone produces local bone damage but no thrombosis of vessels. The morrhuate does not penetrate the blood vessels. It does enter the marrow spaces. A certain amount of irritative necrosis of the bone ensues. When Staphylococcus aureus is implanted on this soil by either the intravenous or the metaphyseal route, an osteomyelitis invariably develops.

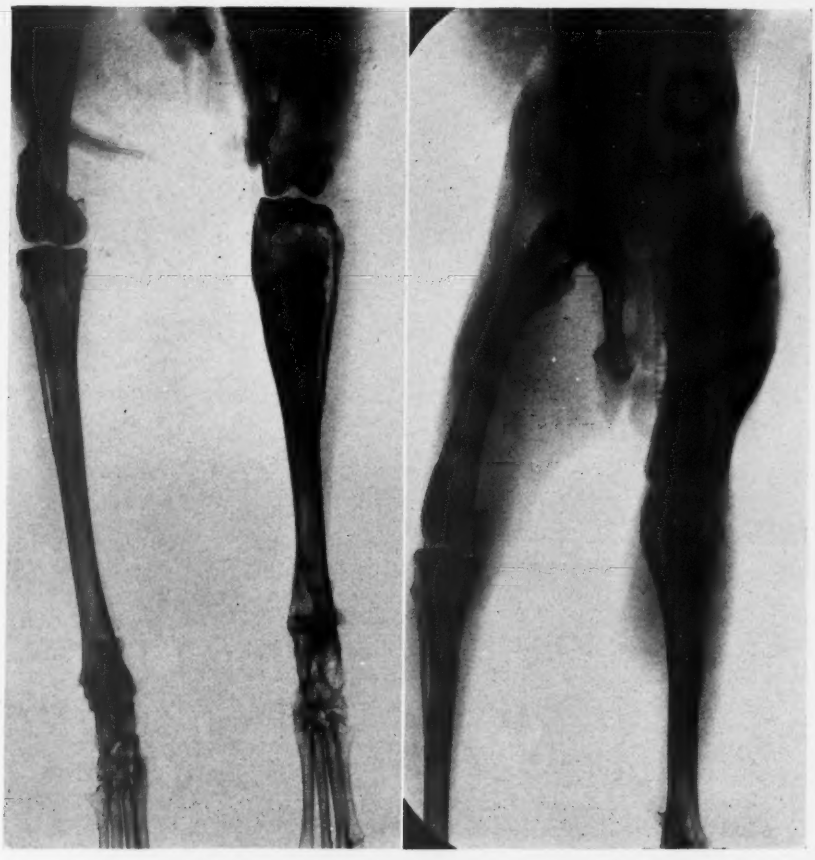
From the results of a large number of experiments, it may now be considered certain that unless the proper soil exists in the bone, neither intravenous nor

The necrosis produced by the injection of sodium morrhuate into the metaphysis is not severe. Unless infection supervenes, complete regeneration is noted in about three and one-half weeks. (Fig. 8.) The necrosis is barely evident in roentgenograms. In some there is slightly increased density of a diffuse nature; in others there are areas of rarefaction; in many, no detectable change.

Abundant evidence substantiates the thesis that in the natural history of this disease bone damage occurs early and precedes the development of the panostéitis. The end result of the morrhuate injection is, therefore, damaged bone. The result of its infection is osteomyelitis.

The roentgenographic picture and the pathologic specimens are comparable with those seen in human osteomyelitis. Some

of the local pathologic changes so characteristic of the disease in man, which we have reproduced experimentally, are: changes in circulation, emboli, infarction, anemia, necrosis, sequestration, involucrum formation.



A B

FIG. 2. A, osteomyelitis o right tibia of four weeks' duration produced by the intrametaphyseal injection of .3 cc. of sodium morrhuate followed in one hour by the injection of .2 cc. of a $\frac{1}{50}$ dilution of a broth culture of hemolytic staphylococcus aureus. B, same rabbit as in 2A fifty-three days after the induction of osteomyelitis. Healing is evident; epiphysis and knee joint are not involved.

Consequently we believe we have a reliable method of producing experimental osteomyelitis in rabbits and dogs, which is capable of further development.

Our experiments re-affirm the following facts: (1) The firm attachment of periosteum at the epiphyseal line safeguards the neighboring joints. (2) The epiphysis is a strong barrier against the spread of infection. (3) Spread of the infection to a joint is unusual (except in the hip).

In the majority of osteomyelitic tibias the neighboring epiphyseal plate (juxtametaphyseal) is involved. There are large collections of polymorphonuclear cells and some necrosis of bone trabeculae; new bone is laid down at the epiphyseal line, and with longitudinal growth the area of necrosis gradually is separated from the epiphyses. Rarely has there been destruction of the epiphyseal plate and involvement of the epiphyses and the joint.

In one animal we noticed complete destruction and restoration of a whole epiphyseal plate three weeks after morrhuate injection. This was in a control, i.e., a non-infected animal. The process of regeneration following the damage produced by the morrhuate is remarkable for its rapidity. In most cases the regeneration is well advanced in three weeks.

In an animal which had an osteomyelitis of the tibia produced by sodium morrhuate and intravenous Staphylococcus aureus, damage it produces is not extensive and is practically microscopic. We have seen in morrhuate-control animals complete repair

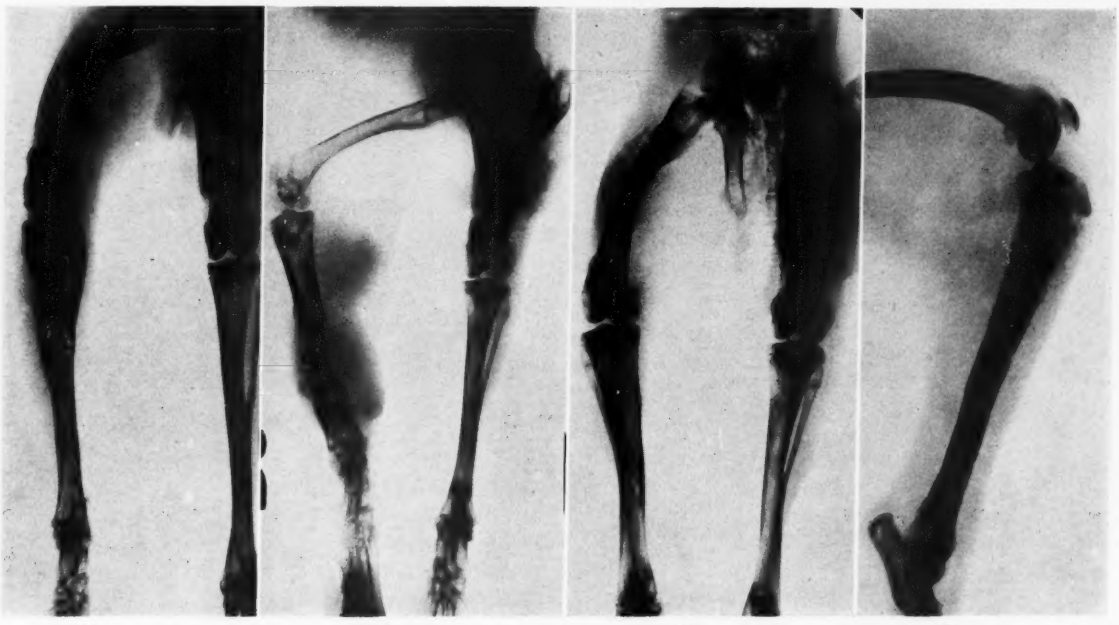


Fig. 3. Fig 4. Fig 5. Fig. 6.

Fig. 3. Osteomyelitis of the right tibia seven weeks after experimental induction. Note marked thickening and periosteal new bone formation.

Fig. 4. Experimental osteomyelitis of the right tibia in rabbit two and one-half weeks after induction. Note that the epiphyseal plate and epiphysis are intact. Sequestration of the tibial shaft, involucrum formation and large soft tissue abscess are evident.

Fig. 5. Right tibia of rabbit eight weeks after experimental induction of osteomyelitis. Healing is well advanced. Note sequestrum in midshaft.

Fig. 6. Experimentally induced osteomyelitis of the left tibia seventeen days old. Note cortical destruction of extensive degree.

a metatastic osteomyelitis lesion appeared during the third week in the lower part of the left femur. This is the only instance of metastatic osteomyelitis in the whole series.

We are convinced that the earliest lesion in osteomyelitis is damage to bone tissue. Whether in man the soil is provided by trauma, or whether necrosis and infection are concomitantly due to an infected embolus, remains unknown. Our own experiments seem to prove that changes in bone once initiated, constitute primarily a local phenomenon, with, of course, the possibility of metastasis. The receptive soil for an osteomyelitis is damaged bone. Bacterial infection alone does not produce osteomyelitis; it must lodge in a receptive soil. The use of sodium morrhuate is a "lucky strike," in that the and regeneration in three weeks, provided there is no infection.

The osteomyelitis we have developed is a pan-osteitis, as distinguished from the local osteitis produced by bacterial inoculation of bone. The majority of bone infections seen in compound fractures appear to us as in the nature of an osteitus, and when a real osteomyelitis develops, it is probably due to a self-propagating thrombus arising at the site of fracture, as a result of neighboring soft-tissue infection. If this is true, the importance of *débridement* is self-evident in order to remove all potential sources of infected thrombi which may advance in the direction of the periosteal and subperiosteal vascular systems. This would be especially true in the region of the nutrient vessel to the shaft and its primary and secondary branches.

The experimental osteomyelitic picture exhibits an acute stage, characterized by local tumor, pain, redness and heat, before, during and after development of the osteomyelitis, did not change the course of the infection or alter the *x*-ray

A B

Fig. 7. A, experimentally induced osteomyelitis of right tibia of rabbit of fifty-two days' duration. Practically the entire shaft is involved. B, same rabbit as in 7A seventy-three days after the induction of osteomyelitis. Healing is well advanced, epiphysis is intact despite severe metaphyseal involvement.

without early *x*-ray findings, but developing into subacute and chronic stages with definite *x*-ray changes. The entire process takes about three weeks: the acute stage lasts about ten days; the subacute, the week following the acute, with a heavy involucrum in two to two and a half weeks, the chronic stage following the acute three weeks. The rapidity of the process may be accelerated by an excessive amount of sodium morrhuate, causing too much necrosis. The *x*-rays reveal destruction of bone, periosteal proliferation, sequestration, involucrum and abscess formation. In no instance did draining sinuses develop.

Sulfathiazole administered to rabbits findings. Nor was the incidence of mortality affected. Even though the osteomyelitic picture did not vary under its use, it was suspected of debilitating the animals.

Results of chemotherapy by the enteral route in rabbits should be accepted with caution. Blood levels cannot be maintained nor absorption be regular, due to the herbivorous sac-like stomach of rabbits. Dogs might be more suitable for such experimentation.

In the sulfathiazole experiment one group of animals was fed 1 Gm. of sulfa drug in divided doses, daily. In another group the drug was withheld for purposes

of control. All of these animals afforded *x*-ray evidence of chronic osteomyelitis, but showed no draining sinuses. These were all young rabbits. The same experiment should be repeated on adult rabbits.

FIG. 8. Microphotograph showing metaphysis of rabbit's tibia thirty-four days following intrametaphyseal injection of .2 cc. of sodium morrhuate. Zone of necrosis (*b*) separates original provisional zone of calcification (*a*) from regenerated epiphyseal plate and osteoid columns (*c*). × 30.

While the drug apparently had no effect on the course of the osteomyelitis, the animals receiving it became quite debilitated, compared with the control group. Cultures from blood and bone yielded Staphylococcus aureus. The pus cultured from infected bones likewise always yielded Staphylococcus aureus. In most instances the blood culture was positive for the same organism. This was also true of the sulfathiazole-treated animals. A study of blood sulfathiazole concentration, though carried out, proved unsatisfactory.

It has been suggested that the young rabbits originally experimented upon, offered an osteomyelitic picture similar to that of children during their first year. Especially massive involvement and heavy periosteal reaction appear in both pictures. Also the hematogenous osteomyelitis of infants always presents a different problem from that seen in older children and adults. Infants usually overcome the infection under simple supportive therapy, and rarely show draining sinuses.

Bone formation in our rabbits was massive and large involucrums formed. To determine whether the osteomyelitic

course is different in old rabbits, further experimentation is being carried out. The rabbits now employed are adults with introduced and a plaster cast applied. The result may disclose chronic osteomyelitis with draining sinuses. The controls

FIG. 9. Microphotograph showing metaphysis of rabbit's tibia indicating experimentally induced osteomyelitis of three weeks' duration. Zone (*a*) osteoid columns. Note necrosis and purulent exudate; zone (*b*) fibrous tissue; zone (*c*) living bone. × 65.

closed epiphyses. They readily develop osteomyelitis. The course of the infection is as yet too recent for further report at this time. The infection has been successfully reproduced in dogs but not treated experimentally as yet. Valuable results are expected from these animals.

Beside those already indicated, many experimental problems in the treatment of osteomyelitis are now under way. One involved early operation upon the infected tibia before *x*-ray evidence was present. A window was made in the tibia for drainage; the inflammatory marrow was cultured and invariably yielded Staphylococcus aureus; a vaseline pack was never developed any. If chronic osteomyelitis can be produced by early surgery, treatment of this type of osteomyelitis by further surgery, combined with sulfa drug and vaseline pack technics, will be attempted.

The excellent clinical reports of Hoyt and his associates on the nonsurgical treatment of acute osteomyelitis, may be possible to duplicate experimentally. They used both sulfathiazole and sulfadiazine, without surgery. Even frank, fluctuant, subcutaneous abscesses were not drained. None of their patients developed sinuses. How often does one see draining sinuses in unoperated osteomyelitis? Is it not true

that most of them are operated upon and that the combination of acute osteomyelitis plus surgery may account for many of the draining sinuses?

sulfathiazole therapy. Such an outcome depends on the fundamental basis in the development of an osteomyelitis: bone damage and infection. If the infection is

Fig. 10. Diagrammatic representation of the important etiological factors in human osteomyelitis.

Perhaps some animal other than the rabbit, which we believe cannot be adequately sulfa-drugged, is more tolerant and absorbs the drug, developing beneficial results comparable to those in man. If sulfatherapy is tolerated adequately by an animal, the course of experimental osteomyelitis will probably be modified. Even if the bone field has been prepared, osteomyelitis may not develop in an animal saturated with sulfathiazole.

At this point a fine opportunity is offered for comparison of results from operative and nonoperative methods. We may compare (1) patients with acute cases of the disease who have been operated upon but have had no sulfathiazole therapy, with (2) patients with acute cases of the disease who have had sulfathiazole therapy but no surgery. We should expect the comparison to show a greater percentage of chronic osteomyelitic cases with drainage sinuses from the first group: the acute cases, operated on, but receiving no controlled, the bone may repair itself to a great degree and necrotic bone may be absorbed by osteoclastic activity and phagocytosis. Wilensky long ago stressed the point that surgery is often meddlesome and adds insult to injury. With the advent of sulfathiazole, the comment may be even more true. Certainly recent reports indicate that acute "osteos" do well if left alone, except for supportive measures and for chemotherapy.

The following program of experimental therapy is now being carried out by us on rabbits with open and with closed epiphyses. These animals show definite *x*-ray evidence of chronic osteomyelitis but have no draining sinuses.

1. The control animals have never had sulfathiazole nor been subjected to surgery. They have chronic osteomyelitis without draining sinuses, and will be permitted to live until the end comes naturally. *X*-rays will be made at regular intervals to observe the course of the osteomyelitic process.

2. Other rabbits have chronic osteomyelitis without sinuses but had been used in the sulfathiazole "before, during and after" experiment. The drug had not affected the course of the infection one way or the other. One Gm. of the drug had been given in daily feedings in divided doses. When the drug was stopped, these animals had had osteomyelitis on an average of eight weeks, but had been without the drug for about three weeks when this experiment was started. (*Staphylococcus aureus* culture from bone was positive at the time of the ensuing operations.)

Group 2 has been broken up into the following subgroups: (A) Resection of entire infected portion of tibia subperiosteally followed by primary suture of wound and plaster cast; (B) resection of entire infected tibia subperiosteally with sulfathiazole implantation into the periosteal tube and soft tissues, plus primary closure of the wound and a plaster cast; (C) saucerization of the tibia, plus vaseline pack and plaster cast (Orr); (D) saucerization of tibia, wound left open (without vaseline pack) and plaster cast; (E) saucerization of tibia, sulfathiazole implantation and wound left open without vaseline pack or plaster cast, and (F) controls: sulfathiazole animals without surgery.

Factual data on therapeutic results of the problem are not yet ready. The animals tolerate the casts; the wounds heal rapidly and some sinuses have formed. Many months of experimentation will be required before conclusive data are available.

The experimental animals exhibit constitutional symptoms and local manifestations. They have fever during the early stage, associated with anorexia and lethargy. Most of the rabbits have positive blood cultures. A "pseudoparalysis" of the legs is probably due to pain. The sedimentation rate and blood count studies for leucocytosis were not carried out carefully enough for clinical evaluation.

Within twenty-four to forty-eight hours, the injected leg appears markedly swollen. The bony outlines of the leg are decidedly less sharp. The skin of the injected leg appears slightly hyperemic and warmer than the other leg. This applies to the morrhuate controls as well as to the infected animals. The morrhuate produces an irritative, aseptic inflammatory reaction; after the first week the morrhuate control animals quickly return to normal. The clinical picture continues in the infected animals.

The first week after the injection the animals seem somewhat lethargic, often have drooping ears and sit in their cages favoring the injected leg by raising it off the bottom of the cage. There is usually some loss of weight during the first week after the injection.

Heart-blood cultures taken forty-eight to seventy-two hours after injection of the leg with sodium morrhuate and Staphylococcus aureus are often positive for Staphylococcus aureus, becoming negative within ten days.

This coincides with observations in the literature on blood cultures in animals after injection of cultures (Koch and others). When our animals die and a positive culture is obtained from the blood, the early bacteremia has been superseded by a septicemia, with bacteria growing in the peripheral blood and not dependent on the feeding focus, i.e., the osteomyelitis. Could such animals be given effective chemotherapy and be kept alive, it would prove that fulminating osteomyelitis in the presence of a septicemia rather than a bacteremia should never be operated upon but should be given supportive treatment and chemotherapy. Our animals show the same purulent foci in all vital organs, especially the kidneys, as noted in human "osteos" of this type. The osteomyelitis appears to be unimportant in comparison with the septicemia, which is usually fatal.

Routine cultures are not taken, because an abscess results at the site of entrance of the needle into the heart of those animals having a positive blood culture.

When very young rabbits are used (2 pounds), there is a rise of one to four

degrees in body temperature during the first week. The temperature remains normal during the chronic stage of the osteomyelitis. Older rabbits exhibit no increase in body temperature. The average normal body temperature of rabbits is 101.5°F.

A large and important group of experiments can be performed to clarify the mechanism of osteomyelitis in compound fractures. (1) Produce a compound fracture of the femur or tibia. Apply virulent (for the animal species used) staphylococci locally to the wound depths. (2) Same as (1), but first strip the periosteum in the region of the nutrient artery, to cause a certain amount of bone necrosis. (3) Same as (1), but first attempt to localize and thrombose the nutrient artery, using sodium morrhuate. (4) Same as (1), but also produce an infected thrombus in a fair-sized neighboring vessel in muscle or fascia or an infection in the soft tissues which will secondarily give rise to a propagating infected thrombus.

The following questions remain to be clarified: Does the morrhuate act directly on the bone elements, or is vascular thrombosis an important factor in the aseptic necrosis? What is the smallest amount of morrhuate which, when injected, will lay the foundation for osteomyelitis after the addition of live bacteria, either intravenously or intrametaphyeally? Such information is very important to avoid using too much morrhuate. An excessive morrhuate action may account for the rapidity of the osteomyelitic process which we have seen in our animals. A minimal amount may permit a slower development, simulating more closely human osteomyelitis, and perhaps also cut down the mortality. How far does the morrhuate diffuse after injection, and how far does the aseptic necrosis extend, with varying degrees? We want to combine with the morrhuate a radiopaque substance either thorotrast or lipiodol, so that the action can be localized. It would then be possible to determine the extent of diffusion of the morrhuate in a roentgenogram. We tried to do it with charcoal, but that involves the study of microscopic sections, which is a laborious task. Does one note the first microscopic changes following morrhuate injection in hours or days? What is the longest interval which may elapse between the morrhuate (injury) and bacterial injection (infection) in order to produce osteomyelitis? What happens to the experimental osteomyelitis if allowed to go indefinitely without sacrificing the animal? Does it go on to a chronic phase? Or does it heal? Does the infecting dose determine the subsequent course, or is the osteomyelitic once initiated self-propelling, regardless of whether the dose is minimal or maximum? What factors determine the death of the animals rather than their living and developing osteomyelitis? Do they concern dosage, virulence, lack of resistance generally? Will animals rendered sensitive to bacterial products, develop a more fulminating osteomyelitis, or will the process tend to localize because of a hypersensitivity reaction? Compare the tubercle of tuberculosis and the galloping pneumonic type. Further analysis of our present experimental work will answer many of these questions in due time. Other questions will be solved by future experiments.

If one may be permitted to speculate on the morrhuate phase of the work alone, there are ample analogies for experimental production of many clinical entities. Consider the possibilities of the aseptic necrosis problem with experimentation in the Legg-Calve-Perthes disease, osteochondritis and epiphyseal growth. One might also consider the production of osteoid-osteoma, bone tumors and degenerative joint diseases of the chronic arthritic type. The field of experimentation in osteomyelitis itself is vast and practically virgin.

In addition to those mentioned elsewhere, we received encouragement, assistance and guidance from Drs. Ludvig Hektoen, Edwin W. Ryerson, Hollis Potter, C. Howard Hatcher, Robert A. Arens and especially Dallas B. Phemister.

A NEW TREATMENT FOR ACUTE DILATATION OF THE STOMACH

EDWARD G. JOSEPH, M.D.
Attending Surgeon, Hadassah University Hospital
JERUSALEM, PALESTINE

THE prevalent opinion is that acute postoperative dilatation of the stomach generally follows upper abdominal surgery, and that it is very amenable to treatment. Such, however, is not the case. Acute dilatation of the stomach may follow almost any type of operation in any part of the body. All methods of treatment, hitherto advocated, may be unsuccessful and the condition may result in the death of the patient.

Thomas[1] reports two such deaths. In one case a male aged forty-one, had had a thoracoplasty and phrenicectomy. The postoperative course was uneventful until the fourth day, when the patient became dyspneic and cyanotic, developed a rapid and thready pulse and died that same day. At autopsy, the only finding of importance was acute dilatation of the stomach.

The second case was a male, aged twenty-six, on whom also thoracoplasty and phrenicectomy had been carried out. On the second postoperative day, the patient's abdomen became greatly distended. The patient developed marked dyspnea, cyanosis and a very rapid pulse and died in forty-eight hours. At autopsy, the only significant findings was acute dilatation of the stomach.

Johnson and Rabinowitch[2] report a death from acute dilatation of the stomach in a male, aged twenty-nine, who had been operated upon for Dupuytren's contracture. A plastic operation had been performed and the hand was sutured to the skin of the thigh.

On the third postoperative day the patient developed abdominal pains and vomiting. Vomiting continued for nine days. There was no improvement following gastric lavage. Extreme toxemia developed, incessant vomiting continued, and the patient died on the tenth day.

At autopsy, the stomach and duodenum were found to be dilated and there appeared to be an obstruction at the third part of the duodenum, where it is crossed by the fold of mesentery which contains the superior mesenteric artery.

The intestine below the point of obstruction was contracted and empty. By lifting the mesentery overlying the third portion of the duodenum, the obstruction was partially released and some of the duodenal content passed into the jejunum.

Lorenzetti[3] advocates jejunostomy for the treatment of acute postoperative dilatation of the stomach. The cases above cited and the surgical treatment suggested by Lorenzetti[3] indicate the following: (1) Acute dilatation of the stomach may follow operations carried out on any part of the body. (2) The generally accepted method of treatment, namely, gastric lavage may be completely ineffective. (3) Jejunostomy has been advocated for the relief of this dangerous condition. (4) Postoperative acute dilatation of the stomach is a dangerous complication and may result in the death of the patient.

SYMPTOMS

In acute dilatation of the stomach the epigastrium may be distended while the lower part of the abdomen remains soft and flat. Vomiting is usually intermittent but persistent, and enormous quantities of fluid may be regurgitated.[4,5] The vomitus consists of green or brownish-black fluid which is generally odorless and neutral in reaction.

The vomitus contains little or no free hydrochloric acid and nearly always contains bile, and other digestive secretions from the upper part of the alimentary tract.

Nondistention of the jejunum and ileum, normal intestinal peristaltic activity and normal bowel movements aid in differentiating acute dilatation of the stomach from paralytic ileus.

The blood urea values are always high and persistent vomiting results in a sharp lowering of the blood chlorides.

ETIOLOGY

Carlson and Luckhardt[6] and Alvarez[7] have shown that the alimentary tract possesses a peripheral automaticity which is similar to that of the heart. Section of the vagus nerves or of the sympathetic branches to the heart does not result in paralysis of the cardiac musculatures. Similarly, section of the extrinsic nerves of the stomach does not produce gastric paralysis.

Dragstedt and his co-workers[4,5] have repeatedly sectioned both vagi, as well as both vagi and splanchnics in dogs, without producing any evidence of gastrointestinal paralysis. They state that it has been clearly demonstrated that a primary occlusion of the transverse portion of the duodenum by the superior mesenteric vessels was responsible for acute dilatation of the stomach. They claim that it can be easily demonstrated experimentally that a stenosis of the duodenum results in a gradual dilatation and hypertrophy of the part above the obstruction. Acute dilatation of the stomach, however, has never been reported following experimental stenosis of the duodenum.

Novak[8] has pointed out that acute dilatation of the stomach has been described in the relatively few cases of high intestinal obstruction, from various causes, that have been reported in the literature. The occurrence of acute dilatation of the stomach during the course of an operation, with the patient in the Trendelenburg position, would seem to rule out the possibility that duodenal obstruction plays any rôle in the production of acute dilatation of the stomach.

Dragstedt and his coworkers[4,5] believe that it is far more probable that acute dilatation of the stomach following surgical operations or manipulations, including extensive stimulations of either somatic or visceral sensory nerves, is due to reflex inhibitions of the stomach through the efferent fibers in the vagi and splanchnic nerves. The peripheral gastric motor mechanism is depressed at the same time by the anesthesia, debilitating disease, or the malnutrition of the patient. They believe that the functional and anatomic conditions present in acute dilatation of the stomach prevent the passage of the gastric and pancreatic juices and of the bile from passing into the lower intestine, so that these fluids accumulate in the dilated stomach.

The evidence suggests that a primary or acute gastric dilatation, reflex in origin, occurs either during the course of an extensive operation or immediately afterward. This is followed by a secondary mechanical occlusion of the inferior horizontal portion of the duodenum, either by direct pressure of the dilated stomach against the duodenum or by a secondary arteriomesenteric compression resulting from the downward pressure of the dilated stomach which forces the small intestines into the pelvis.

TREATMENT

The commonly accepted form of treatment for acute dilatation of the stomach is to insert a tube into the stomach either through the nose or directly through the mouth. The stomach is then thoroughly and frequently irrigated through this tube. At the same time, to counteract the loss in blood chlorides, saline and glucose are given in large quantities intravenously.

It is important to remember, however, that the above mentioned procedures may prove to be completely ineffective in some cases, and that the patient may continue to vomit, go rapidly downhill, and die.

Four years ago the writer introduced a new form of treatment on the surgical service of the Hadassah Hospital in Jerusalem, that has saved, without question in the writer's mind, the lives of six of his patients.

Clinical observations of patients on the surgical wards of the Hadassah Hospital extending over a period of many years, has convinced the writer that the surgical complication of acute dilatation of the stomach probably was not caused by ether or spinal anesthesia, or that it resulted from any specific operation, or from operation on any specific part of the body.

The writer observed that all the patients who developed acute dilatation of the stomach had only one common factor, namely, the enforced confinement to bed following the operative procedure. It seemed to make no difference whether these patients had been kept in a horizontal position or had been propped up in bed. The one common and determining factor was the enforced confinement to bed.

It seemed logical, therefore, to reverse this state of affairs, and to force these patients to stand upright, and to aid them in taking a few steps. It was fully realized that a heroic method of treatment of seriously ill and debilitated patients was being proposed. However, it seemed justified in an effort to save life.

On paper the procedure sounds simple. In practice, however, it is not an easy task. The patient is on the verge of exhaustion from his long continued vomiting. He generally can hardly lift a limb or move his head, and is completely helpless. It requires, therefore, the aid of three strong men to lift the patient gently from his bed, to hold him upright on the floor, and to aid him in taking a few steps. The writer is well aware that the advocacy of this form of treatment sounds cruel and unorthodox. However, uncontrolled acute dilatation of the stomach with persistent vomiting, results in almost certain death of the patient, and the writer's experience has convinced him that the treatment advocated offers the patient probably his one chance for survival.

The results, once the patient is placed in the erect position, are extremely startling. The patient will experience a gurgling sensation in the throat and will belch. He will, generally, ask for a drink and will at once be able to swallow half a cupful of water without nausea. After being supported in the erect position for ten minutes and after aiding him in taking a few steps, the patient is gently laid down on his bed. In two or three hours the treatment is repeated, if necessary. Usually, after this, the vomiting stops and the patient begins to feel much more comfortable.

CASE REPORTS

CASE I. A male, aged sixty-five, in good physical condition had had a suprapubic cystostomy under low spinal anesthesia. His blood urea value was within normal limits. Following the operation, he began to vomit greenish colored fluid in large quantities. A diagnosis of acute dilatation of the stomach was made. A stomach tube was then passed through the nose and the stomach was washed out thoroughly at half hour intervals. The patient's condition, however, did not improve. He could not retain any food or water. In accordance with the customary procedure in such cases he was given intravenously several liters daily of normal saline and glucose. In spite of this the patient's blood urea began to rise. Vomiting of large quantities of greenish-black fluid continued for fourteen days. It was obvious clinically that the patient would die, unless his vomiting could be controlled.

In desperation, and since it seemed very unlikely that the operation had had anything to do with the development of the acute dilatation of the stomach the writer decided to force the patient to get out of bed and walk.

Notwithstanding the patient's bitter protests, he was made to stand up and was forced to take a few steps. He at once regurgitated some gas, and asked for a drink, which he kept down. From that moment vomiting stopped, and the patient made an uneventful recovery.

CASE II. A middle aged, obese, male had had a cholecystectomy. Following the operation the patient began to vomit and, in spite of the usual treatment, vomiting continued for six

days. On the seventh day, when the patient's condition became critical, he was lifted out of bed, was made to stand up and was encouraged to take a few steps. From that moment his condition improved.

Case III. A young male with a duodenal ulcer had had a Hofmeister-Pólya gastrectomy performed under spinal anesthesia. The stoma did not function. Consequently an anterior gastrojejunostomy with an extero-enterostomy was performed several days later. The patient developed postoperative acute dilatation of the stomach which failed to respond to the usual treatment. On the fifth postoperative day the patient's condition became extremely critical and it was obvious that something drastic had to be done to save the patient's life. He was consequently lifted out of bed and put into the erect position. Again the above described phenomenon occurred. The patient eructated gas freely, and drank some fluid which he was able to retain. Vomiting stopped, and the patient made a splendid recovery.

Case IV. A male patient had had a resection of a large segment of the ileum, which became gangrenous following a volvulus. An acute dilatation of the stomach developed postoperatively, which was treated unsuccessfully with the usual methods for several days. On the eighth day, with the patient in an extremely weakened and critical condition, he was lifted out of bed and made to stand up. The result was very spectacular. Vomiting stopped abruptly and the patient made an uneventful convalescence.

Case V. A male, sixty-eight years old, who had a large gastric ulcer, had an anterior gastrectomy performed by the Hofmeister-Pólya technic, under continuous spinal anesthesia. There was a normal postoperative recovery until the tenth day. On the following day, however, the patient began to vomit incessantly. Gastric lavage failed to effect the vomiting in the slightest degree, and the patient's condition rapidly deteriorated. It was then decided to lift the patient out of bed and to make him stand up. The procedure was carried out and the patient almost immediately belched. His subsequent recovery was uneventful.

Case VI. A young woman who had had a cholecystectomy and appendectomy suddenly began to vomit on the fifth postoperative day. She vomited huge quantities of blackish fluid for three days. The patient could not tolerate passage of a regular stomach tube through the mouth and an irrigating tube could not be passed through the nose. The patient's condition became very critical and it was decided to lift her out of bed and to make her stand up. As soon as this was done the patient's nausea and vomiting ceased abruptly. She immediately began to retain fluids and made an uneventful recovery.

SUMMARY

1. Acute dilatation of the stomach is a postoperative complication which, generally, is easily controlled.

2. Occasional cases of acute dilatation of the stomach occur which do not respond to the usual treatment by gastric lavage and intravenous injections of glucose and saline. In these cases the incessant and uncontrolled vomiting causes the death of the patient from dehydration and toxemia.

3. The postoperative complication of acute dilatation of the stomach does not seem to be caused by ether anesthesia or by spinal anesthesia, and may follow any type of operation, in any part of the body.

4. The one common factor in the cases of acute dilatation of the stomach, observed by the writer, was the enforced confinement to bed following an operative procedure.

5. A new treatment is described and advocated in cases of acute postoperative dilatation of the stomach, which cannot be controlled by the usual and orthodox forms of treatment.

6. The treatment advocated consists of gently lifting the patient out of bed and supporting him in an erect position for approximately ten minutes. He should be encouraged and aided in taking a few steps. This maneuver should be repeated after a two or three hour interval in those cases that do not respond satisfactorily or completely to the first attempt.

7. This new form of treatment has been effective in saving the lives of all six of the writer's cases in which death seemed to be imminent from the dehydration and toxemia caused by the incessant and uncontrolled vomiting of postoperative acute dilatation of the stomach.

REFERENCES

1. THOMAS, C. A. Acute dilatation of the stomach following left sided phrenic paralysis and thoracoplasty. *J. Thoracic Surg.*, 5: 507, 1936.
2. JOHNSON, J. G. W. and ROBINOWITCH, I. M. Clinical and biological findings in two cases of acute dilatation of the stomach. *Canad. M. A. J.*, 22: 811, 1930.
3. LORENZETTI, C. Treatment of acute post operative dilatation of the stomach by jejunostomy. *Atid. d. Sec. Ital. die. Chir.*, 36: 98, 1930.
4. DRAGSTEDT, L. R., MONTGOMERY, M. L., EDIS, J. G. and MATHEWS, W. B. Pathogenesis of acute dilatation of the stomach. *Surg., Gynec. & Obst.*, 52: 1075, 1931.
5. DRAGSTEDT, L. R. and DRAGSTEDT, C. A. Acute dilatation of the stomach. *J. A. M. A.*, 79: 612, 1922.
6. CARLSON, A. J. and LUCKHARDT, A. B. Vagal control of the oesophagus. *Am. J. Physiol.*, 56: 299, 1921.
7. ALVAREZ, W. C. An Introduction to Gastroenterology. New York, 1939. Paul B. Hoeber.
8. NOVAK, J. Acute postoperative dilatation of the stomach. *J. A. M. A.*, 77: 81, 1921.

COMPLETE abortion is evidenced by the extrusion of an intact product of conception or by the prompt cessation of symptoms and the normal progress of involut.on. The after-treatment is that of the puerperium.

THE DANGERS OF BORIC ACID*

ITS USE AS AN IRRIGANT AND REPORT OF A CASE

CHARLES A. ROSS, M.D. AND JOHN F. CONWAY, M.D.†
GALESBURG, ILLINOIS

INTOXICATION with boric acid and other borate compounds is a constant threat which physicians and laymen rarely appreciate. Boric acid is an insidious, carelessly used, poisonous drug with power of fatal poisoning. To illustrate the seldom appreciated dangers a survey was made of the medical men in a typical midwestern community. Of thirty doctors questioned twenty had never heard of boric intoxication, nine knew that boric acid could cause poisoning when ingested, one had seen a case of boric poisoning, and none knew that boric acid could be absorbed in fatal quantities when used as an irrigant in body cavities.

Boric acid compounds are widely used with impunity by both medical and lay groups for a great number of purposes. (Table 1.) The eyes of almost every newborn infant are cleansed with boric acid in hospitals and homes in spite of such catastrophies as the six infants in a Chicago hospital[13,20] who died of accidental boric acid ingestion in 1927. It is a common practice to use boric acid as an antiseptic for rubber nipples and to cleanse the nipples of nursing mothers. Even in the literature accompanying a popular brand rubber nipples boric acid is recommended for purposes of sterilization. Yet Aikman[1] lists a case of boric acid poisoning in a two-day old infant due to nursing its mother's breast after boric acid had been used as a nipple wash. Boric acid and borate compounds are usually dispensed without a poison label and may be found upon the medicine shelf of any home. Nevertheless, Potter[27] reports a fatality from the accidental ingestion of an ounce of borax by a sixty-six-year old adult. We have never seen any hospital institution in which special care was taken in labeling and storing boric acid solutions. Notwithstanding, serious intoxication from the accidental administration of such solutions intravenously and by hypodermoclysis has occurred.[8,10,15,26] As Max Trumper[30] so well states: "The common use of boric acid in medicine as a mild antiseptic in the nose, throat, eye, and other cavities has served to create such an impression of its harmlessness that its potential danger as a poison has been neglected."

The harmful effects of the use of boric acid preparations as food preservatives have been so well established that such practice is illegal in the United States, France, Germany, Holland, Italy, Spain, and Great Britain.[13,20] For many years this procedure was debated until an extensive literature on both sides of the argument developed, particularly in Great Britain. During this controversy it was well established that boric acid could produce harm when ingested in large quantities in a single dose or in small quantities over an extended period of time.[11,20,26,27,29]

That boric acid may be absorbed from body cavities in sufficient quantities to produce fatal poisoning is little known. Hence, it is widely used without precaution as an irrigant of the pleural cavity, urinary bladder, infected wounds, conjunctival sac, vagina, mouth, sinuses and colon.

PHARMACOLOGY

Boric or boracic acid occurs either as white, translucent scales or as a powder with a slight acid reaction. It is freely

* From the Gunning Clinic.† Dr. Ross is now on active duty in the U. S. Navy and Dr. Conway is with the U. S. Army Air Corps.

soluble in boiling water, alcohol and glycerin. It is commonly used as its sodium salt, borax or sodium borate, and as the preparations are the glycerite of boroglycerin composed of 310 parts boric acid and 690 parts of glycerin and the boric acid

TABLE I

SUMMARY OF USES OF BORATES

	Uses	Methods and Preparations Employed	
Medical Uses in Hospital and Office	Infected wounds[7]	Hot compresses	Saturated boric acid solution
	Burns[18]	Topical applications	Boric solution & crystals
	Ulcers[15]	Topical applications	Boric acid ointment
	Erysipelas	Topical applications	Boric acid powder
	Eczema[29]	Topical applications	In glycerole of starch
	Ichthyosis	Topical applications	Borate of glycerin
	Osteomyelitis	Packs	Saturated boric acid solution
	Lymphangitis[29]	Moist packs & dressings	Saturated boric acid solution
	Cellulitis[31]	Moist packs & dressings	Ochsner solution
	Peritonitis[15]	Enemata	Saturated boric acid solution
	Diarrhea[28]	Colonic irrigations	Saturated boric acid solution
	Dysentery	Rectal irrigations	Saturated boric acid solution
	Colitis[28]	Rectal irrigations	Boric acid solution
	Constipation[3]	Rectal irrigations	Boric acid solution
	Trichomonas vaginalis	Douches	Saturated boric acid solution
	Non-specific leukorrhea[16]	Cervical caps	Boric acid powder
	Specific vaginal infections	Powder insufflators	Boric acid powder
	Monilia	Douches	Boric acid powder
	Obesity[29]	Orally	Boric acid crystals and powder
	Uterine hemorrhage[29]	Orally	Sodium borate
	Thrush lesions of mouth[19]	Orally	Honey and borax
	Epilepsy[28]	Orally	Sodium borate
	Locomotor ataxia	Orally	Sodium borate
	Paralysis agitans	Orally	Sodium borate
	Urinary bladder infections and urinary retention[22,10]	Irrigations	Saturated boric acid solution
	Empyema cavities[23]	Irrigations	Saturated boric acid solution
Home Uses	Eye infections, infants and adults (also medically)[29]	Irrigations	Saturated boric acid solution
	Mother's nipples[1]	Wash	Saturated boric acid solution
	Aphthous stomatitis[29]	Mouth wash and gargle	Borated glycerin
	Pharyngitis	Orally	Honey and borax
	Laryngitis	Orally	Boric acid solution
	Rubber nipples	Antiseptic	Saturated boric acid solution
	Rhinitis	Irrigations	Borated glycerin
Commercial Uses	Food preservatives (illegal many countries)	½0 per cent to 4 per cent adulteration	Boric acid crystals
	Talcum powder	Many formulas	Boric acid powder
	Douche powder	Many formulas	Boric acid powder
	Mouth wash	Many formulas	Boric acid powder
	Antiseptics	Many formulas	Boric acid powder
	Contraceptive jellies	Many formulas	Boric acid crystals
	Other Commercial Uses	Many formulas	Boric acid and sod. borate

acid in saturated solutions which are 4 or 5 per cent strength depending upon the degree of saturation which varies with the temperature of the solvent. Popular official ointment containing 10 per cent boric acid.

Boric acid and sodium borate have questionable antiseptic action.[11] In 2.5 per cent

solutions almost all forms of bacteria stop growing but are not destroyed, even the delicate anthrax being capable of further growth after exposure of 4 per cent solutions for twenty-four hours. Bastedo[2] states that Bernstein demonstrated as early as 1910 that boric acid had power to check the growth of yeasts and harmless saprophytes but had only slight effect upon typhoid and other pathogens.

Buzza and Cerratola[9] reported the toxic dose of boric acid to be 4 Gm. per kilo in rabbits and said that their animals died in twelve to twenty-four hours from central paralysis and gastrointestinal irritation. They, also, said that Gaucher found the toxic dose in guinea pigs to be 1 Gm. per kilo. Negri[24] worked out the minimal lethal dose of boric acid in rabbits to be 0.043 Gm. per kilogram.

In the adult human the toxic dose has never been accurately determined but Gissel[15] states that 15 to 30 Gm. are maximal doses. In an unusual case of accidental boric acid poisoning[19] a forty-two year old white woman received 600 cc. of a 2.5 per cent solution of boric acid in 10 per cent dextrose (or 15 Gm., the oft-quoted minimal adult dose) intravenously. The patient was only mildly toxic and recovered in ten days. Here the rapid renal excretion of boric acid in eighty hours seems to have been a favorable factor. McNally and Rust[20] found 1 to 3 Gm. in infants to be the minimal lethal dose most often mentioned in the literature and reported the autopsies of six newborn infants who died after the accidental ingestion of 3 to 6 Gm. of boric acid per infant.

PATHOLOGIC PHYSIOLOGY

There have been interesting experiences with the local absorption of boric acid from wounds and body cavities. Kahlenberg[17] reported that boric acid, when applied to the unbroken, living, human skin, was the only substance of many tried which appeared in the urine in appreciable quantities. It was found in the urine five minutes after the feet were immersed in boric acid solution.

Sajons and Hundley[29] refer to the separate experiments of Hoffman and of Puppe. Strong fresh frogs were placed with the lower part of their bodies hanging in ½ per cent boric acid solution. The portions of the skin exposed to boric acid developed blisters and epithelial exfoliation. In dogs, whose food contained 2.5 per cent of boric acid, postmortem examination revealed necrotic patches of the stomach and intestinal mucosae.

In Dopfer's case[12] enough boric acid was absorbed from a burn "measuring 13 centimeters" to produce death in three days. Gissel[15] says that Lewin reported several cases in which single applications of boric acid for bladder, rectal, and pleural cavity irrigations caused an erythematous rash. Gissel himself reports a case in which boric acid ointment applied to extensive burns resulted fatally. He believes that healthy granulations in a wound might protect against the absorption of boric preparations. Maguire[18] used hot boric fomentations on a leg wound in a twenty-three-year old female in whom he believed fatal intoxications resulted. As far back as 1899, Tillman[23] reported that Molodenkow saw two cases of vomiting, erythema, and eventual death after boric acid in 5 per cent solution had been used in washing out the pleural cavity in one instance and a lumbar abscess in another. In another case[28] rectal irrigations for dysentery were shortly followed by a bromide-like rash. In Table II we have summarized the salient facts in cases of boric acid and borate intoxications.

Having seen that boric applied locally may cause generalized symptoms it is of interest to note the pathological status in fatal cases. McNally and Rust[20] found that the reported lethal results may be divided into three classes: (1) those in which there was a chemical examination with pathologic and autopsy date; (2) those in which a chemical examination was not made but in which there were histologic observations; and (3) those in which death was due to a

known source of boric acid. Apparently in Class 3 pathologic and autopsy data are lacking. They reported six cases in infants with chemical data indicating that the brain and liver accumulated the higher percentages of boric acid, that is, 0.210 per cent and 0.182 per cent, respectively. The only other case with chemical analysis of organs is that reported by Bazin[3] in a fifteen-year old male whose "generalized peritonitis" was treated with boric acid enemas. Here the chemical examination was limited to the "intestinal tube" and revealed no borates.

It is to be noted that pathological examination of certain organs are repeatedly mentioned in the literature. The brain and liver are mentioned most frequently and are described as either edematous or congested. The gastrointestinal tract is described as inflamed or congested occasionally even in cases in which the borate has not been ingested. Petechial hemorrhages and congestion are mentioned in association with the renal disturbance. In at least three instances, inflammation or hydrops of the pericardium and pleura were noted. (Table II.)

SYMPTOMATOLOGY

Certain symptoms and findings are constantly present in cases in which intoxication has been due to a known source of borate regardless of the route of administration. A typical clinical picture usually starts with nausea and mild shock followed in a few hours by diarrhea, vomiting, and more profound shock, associated with a fall in temperature and the appearance of an erythematous rash. This rash resembles the skin manifestations of scarlet fever. If the patient survives twenty-four to forty-eight hours there is frequently desquamation not only of the areas occupied by the rash but also of the mucous membranes. The skin lesions are distributed over the entire body and in certain cases the finger and toe nails have been discolored.[6] In fatal cases, the terminal picture is one of depression and shock occurring as late as three to five days after the borates have been withdrawn.[5,7,12,15]

CASE REPORT

A white male child, three years of age, was admitted to St. Mary's Hospital on February 4, 1942, with dyspnea, pain in the left chest, cough, and fever present about thirty-six hours. The family history was irrelevant except that a younger sister was having a severe upper respiratory infection. The past history revealed no previous illness of significance. Examination showed a poorly nourished, pale child acutely ill with a rectal temperature of 103.4°F. The pulse was 120 and the respirations 45. There were a few small, firm cervical lymph glands palpable. The child was dyspneic with limitation of respiratory movements in the left thorax. Percussion revealed dullness over the entire left lung. Moist, râles were heard in the left lung, but, for the most part, the breath sounds were suppressed. The abdomen was tense and not tender or distended. The fingernails had a bluish tinge.

The red blood count was 3,720,000 and the hemoglobin was 11 Gm. by the Sahli method. The white blood count was 34,200 with the differential count showing polymorphonuclear cells 86 per cent, lymphocytes 8 per cent and monocytes 5 per cent. The urine had a specific gravity of 1.011, a hydrogen ion concentration of 5.9 and showed a trace of sugar and albumin. The centrifuged urine sediment contained a few Gram-positive cocci. No sputum was obtained for typing because a sulfa drug had been used before admission to the hospital. An *x*-ray film of the chest revealed pneumonic infiltration of the entire left lung.

The patient was placed on a pneumonia routine. Sulfadiazine was administered in doses of ½ Gm. every three hours and regulated so that the daily blood levels were never lower than 8.5 mg. per cent. Five per cent dextrose in Ringer's solution was administered intravenously together with 25 cc. of 50 per cent dextrose twice daily. The patient showed slight improvement the second hospital day. He was able to take fluids orally. Cevitamic acid 100 mg., and ten drops of a cod liver concentrate containing vitamins A and D were given daily. The rectal temperature was 103.6°F. The blood picture and the chest findings were the same.

TABLE II

ANALYSIS OF REPORTED CASES OF INTOXICATION

Author Date Reported Age, Sex	Preparation and Amount of Borate	Method of Administration	Symptoms and Findings	Autopsy Data	Result
Brose[7] 1883 31 yrs.	Powdered with b. a. powder for 5 days.	Leg sore.	Diarrhea. Weakness. Hematemesis.	Congestion of stomach and intestines. Enlarged liver and spleen.	Died.
Molodenkow[23] 1899 (2 cases) Ages unknown.	5 per cent b. a. sol. Irrig. with "15 kilo. 1 hr. at a time."	Pleural cavity. Lumbar abscess.	Vomiting. Erythema of face.	None.	Both died.
Best[5] 1903 Adult, male.	6 oz. b. a. powder.	In wound following excision of inguinal glands.	Vomiting. Papular rash. Weak pulse. Slight fever.	None.	Died.
Dopfer[12] 1905 2 yrs.	B. a. ointment.	13 cm. burn of skin.	Scarlatiniform rash. "Head symptoms." Petechiae.	None.	Died.
McWalter[21] 1907 2 mos.	Borax and honey, 3–16 gm. boxes.	To thrush lesion in mouth.	Erythematous rash. Red lips. Vomiting and diarrhea.		Lived.
Sanders[28] 1912.	B. a. solution.	Rectal irrigation for dysentery.	Bromide rash. Feeble pulse. Delirium.		Lived.
Wilson[32] 1915 7 wks. 6 days.	90 cc. saturated b. a. sol.	Accidental ingestion.	Diarrhea. Vomiting. Miliary rash, later peeled.		Lived.
Maquire[18] 1916 23 yrs. Female.	B. a. fomentations.	Traumatic wound of leg.	Headache. Maculopapular rash. Vomiting.	None.	Died.
Forsyth[14] 1919 8 mos.	7.5 to 10 grains b. a. daily in milk.	Ingested.	None given.		Lived.
Potter[27] 1921 66 yrs., Male.	Borax, 1 oz.	Ingested.	Epigastric cramps. Cyanosis. Choking.	Chemical analysis of stomach contents revealed 1.5 oz. borax. Autopsy: "Nothing abnormal."	Died.
Bazin[3] 1924 15 yrs.	6 tsps. b. a. in 6 cups water b.i.d. for 5–6 days.	Enemata.	Vomiting. Red skin rash. Stupor. Rapid pulse. Coma. Temp. 101°F. No borates found in blood.	Chemical examination of "blood and intestinal tube" negative for borates. Injection mesenteric blood vessels. Marked postmorten changes all organs. Congestion of kidneys.	Died.
Birch[6] 1928 18 days.	1.5 drams honey and borax—1 dose.	Ingestion for thrush.	Wasting. Unconscious. Rectal Temp. 96°F. Lips and nails bright red. Stools "cooked spinach" appearance.	Congestion of liver and kidneys with spots of hemorrhage under capsule. Muscles and skin pink. Honey-like substance in stomach.	Died.
McNally & Rust[20] 1928 (6 cases) Newborn infs.	3–6 grams total dose per infant. (Average Wt. 7#)	Ingestion.	None given.	Chemical analysis of chief organs showed brain and liver to have most boric acid present.	All died.

TABLE II. (*Continued*)

Author Date Reported Age, Sex	Preparation and Amount of Borate	Method of Administration	Symptoms and Findings	Autopsy Data	Result
Aikman[1] 1930 2 days.	Not given.	Nursing mother's nipples which had been cleansed with b. a.	None given.	None given.	Died.
Cushing, quoted by Gissel[15] 1933.	1 liter of 4 per cent b. a. sol.	Subcutaneously.	Edema of eyes. Albumin and W. B. C. in urine. Suppression of urine.	Acute parenchymatous degeneration of liver. Edema of brain. "Hydrothorax and hydropericarditis." Pyelonephritis.	Died.
Schywser, quoted by Gissel[15] 1933.	15 grams of b. a.	Not given.	Anuria. Diarrhea. Colic. Collapse.	Acute degeneration of kidneys and liver. Inflammation of G. I. tract.	Died.
Gissel[15] 1935 4 yrs. Female.	B. a. ointment 30 60 grams.	Applied to bandages to burn areas of skin.	Eyes red and swollen (in 2 hrs. after application). Vomiting. Diarrhea. Burned areas became leathery. Large quantities of b. a. in urine.	Fatty degeneration of kidneys and liver. Bronchopneumonia. Inflammation of epicardium and lower esophagus.	Died.
Brown, Brown and Murphy[8] 1936 45 yrs. Female.	1 liter, 2 per cent b. a. sol.	Subcutaneously.	No generalized symptoms. Albumin and casts in urine. B. a. in urine 4 days.		Lived.
McIntyre and Burke[19] 1937 42 yrs. Female.	600 cc. 2.5 per cent b. a. sol.	Intravenously.	Nausea. Flushing. Vomited once. All b. a. excreted after 8 hrs.		Lived.
Peyton and Green[26] 1941 Youth. Male.	28 grams b. a.	Subcutaneously.	Erythema entire body with desquamation. Dry cough. Distention. Nausea. Vomiting. Sore-throat. Colon bacillus pyelonephritis.		Lived.
Authors' case 1942 3 yrs. Male.	Approximately 4 liters saturated b. a. sol.	Constant irrigation of pleural cavity.	Shock. Diarrhea. Vomiting. Cyanosis. Erythematous rash with desquamation. Rectal temp. 101°F. to 103°F. B. a. in stomach contents.	Hydropericardium. Hydrops ascites. Fatty degeneration of liver. Degeneration of kidney. Brain edema. Increased amounts of b. a. in brain and liver.	Died.

Total number of cases—27 Mortality—74.07 per cent

On the fifth day the clinical picture remained unchanged. An *x*-ray of the chest revealed the left lung still to be consolidated but the right heart border was shifted slightly to the right.

By the eighth day the child was eating well. The blood picture was unchanged and the temperature was 100°F. Another roentgenogram upon the fourteenth day revealed no change in the left lung field with the mediastinal structures shifted to the right thorax so that the right heart border was at the right midclavicular line. The temperature had risen suddenly to 102°F. Thoracentesis gave a purulent fluid from which nonhemolytic streptococci were cultured.

The next day closed drainage of the left pleural cavity with a rubber catheter attached to an apparatus[4] arranged for continuous irrigation with saturated boric acid solution (4 to 5 per cent) was begun; the patient received approximately four liters in twenty-four hours. The next day the child began to vomit and passed a bulky stool. By the end of forty-eight hours, he was drowsy and having continuous emesis and diarrhea. The red blood cells were 3,550,000, the hemoglobin was 11 Gm., the white blood cells were 13,600 and the differential count showed 74 per cent polymorphonuclear cells, 25 per cent lymphocytes, and 1 per cent basophiles.

On the morning of the eighteenth hospital day and seventy-two hours after the boric acid irrigations had been started, the patient was found in profound shock, the rectal temperature was 101.2°F., the radial pulse was imperceptible, and the skin was cold and clammy with cyanosis of the fingernails and lips. The neck, thorax and extremities were covered with an erythematous rash which was sharply demarcated at the base of the fingers and toes and at the edge of the mandible. The boric acid solution was replaced by normal saline as an irrigant. External heat and an intravenous transfusion of 250 cc. of citrated blood helped the shock but the vomiting and diarrhea continued.

The next morning the child was unconscious. The rectal temperature was 103°F., the pulse 108 and the respirations 40. Necrotic patches were found all over the body areas where the rash had been present the day before and in the mouth and throat. There was no favorable response to a half liter of blood plasma or nasal oxygen. The stomach contents gave a strongly positive turmeric acid paper test for boric acid. This same test was negative on the urine. The blood creatinine was 5.0 mg. per cent. The boy expired at 6 P.M. of the nineteenth hospital day, four days after the boric acid solution had been introduced into the pleural cavity and one day after it has been discontinued.

Dr. E. J. Kraus of Peoria, Illinois did the autopsy and rendered a pathological report from which we quote as follows:

"Anatomical Diagnosis:

"1. Empyema of the left pleural cavity drained by an incision in the posterior axillary line.

"2. Extensive atelectasis of the left lung.

"3. Partial atelectasis of the right lung.

"4. Degeneration of the myocardium and dilatation of the left ventricle.

"5. Hydropericardium, hydrops ascites and edema of the mesentery and retroperitoneal tissue.

"6. Central fatty degeneration of the liver.

"7. Moderate acute splenic tumor.

"8. Degeneration of the kidney.

"9. Edema and diminution of lipoid of the adrenal cortex.

"10. Edema of the brain.

"11. Cyst in the choroid plexus.

"12. Extensive erythema of the skin with extensive exfoliation.

"*Gross Pathology*. The skin was greatly altered by an erythema which, especially in the face, on the neck and back, had led to widespread separation of the stratum corneum peeled off in large shreds.

"On opening the skull the meninges were found tense and the leptomeninges hyperemic. The brain appeared swollen, heavy, the gyri slightly flattened. The blood on the cut surface, which showed a striking luster, spread quickly. The gray matter was greyish pink. The ventricles were normally wide. There was a cyst in the plexus choriodeus of the right lateral ventricle the size of a pea. The sinuses of the dura mater were negative.

"The pleural cavity on the left side was for the greatest part converted into an empyema lined by a yellow fibrino-purulent pseudomembrane which was easily stripped off. The empyema extended from the diaphragm almost up to the apex of the upper lobe. The left lung, especially the lower lobe, appeared mostly atelectatic, dark red and firm in consistency. The right lung likewise appeared darker red than usual but for the most part was air con-

taining except the posterior portion of the upper and lower lobe. The pleura did not show any changes. The tracheal and bronchial muscosae appeared reddened.

"In the pericardial sac there was a moderate amount of a clear yellowish fluid. The heart was enlarged due to evident dilatation of the left ventricle. The myocardium was pale red, flabby, and softer in consistency than normal. The valves, aorta, and pulmonary artery were negative.

"In the abdominal cavity there was a moderate amount of ascites. The stomach was slightly distended but was not opened because of a later chemical examination of its contents. The duodenum and small intestines were distended and filled with yellow liquid. The mucosa appeared slightly swollen and reddened. Similarly changed was the large intestine, although to a lesser degree.

"The liver was definitely enlarged, the center of the ascini was straw yellow; the consistency of the liver appeared to be lower than normally.

"The gallbladder, bile ducts and pancreas were negative.

"The spleen was somewhat enlarged, rich in blood, softer than normal.

"The adrenals were swollen, the cortex being edematous and less rich in lipoid than usual.

"The kidneys were swollen, softer than normal in consistency, the cortex appeared pale greyish pink and the pyramids were slightly darker being greyish red in color. The pelvis, ureter, and bladder were negative. The retroperitoneal tissue as well as the mesentery at its root was infiltrated by edema.

"*Histological Pathology.* (1) *Brain:* Sections taken from the left frontal lobe did not show particular lesions in hemotoxylin eosin stained paraffine sections. (2) *Left Lung:* Sections showed complete atelectasis and the atelectatic lungs covered by an old inflammatory pseudomembrane in advanced organization. (3) *Heart Muscle:* No fatty degeneration. Perpendicular striation mostly preserved. No essential changes morphologically demonstrable. (4) *Liver:* Marked diffuse fatty degeneration. Moderate round cell infiltration of the interlobular connective tissue. (5) *Kidneys:* Slight irregular fatty degeneration of the tubular epithelium; hyperemia of the pyramids. (6) The skin showed exfoliation of the epidermis which, in many places, appeared reduced to one-third of its normal thickness. The desquamated layers of the epidermis particularly where the separation had taken place showed the prickle cells swollen and light stained and frequently dissociated from one another. The corium and subcutis were not essentially altered.

"*Chemical Analysis.* Boric acid found in 100 Gm. brain tissue amounted to 112 mg. Supposing a weight of 1,000 Gm. for the markedly swollen brain, its total amount of boric acid was 1.12 Gm.

"The liver showed a lesser amount of boric acid, namely 20.6 mg. in 150 Gm. of tissue. This means, suppose the liver weight was 500 Gm.—a total content of 0.068 Gm. boric acid. (Examined by the chemist, Mr. M. DeCarlo and his assistant.)

"*Pathological Conclusions.* The question as to whether the death of the child has occurred due to the boric acid lavage of the empyema cavity must be answered as follows:

"The presence of 1.188 Gm. of boric acid in the brain and liver allows one to draw the conclusion that the amount of boric acid in the whole body certainly was greater than the amount found in these two organs. Since boric acid is eliminated through the saliva, gastrointestinal tract and urine, we have to assume a greater amount of boric acid having acted on the child during the treatment of three days than the chemical examination performed sometime after the administration of boracic acid has been stopped, could reveal.

"The fact that 3 Gm. of boric acid can prove fatal to an infant illustrates the significance of the 1.12 Gm. boric acid being present in the brain alone, which means in other words, that more than a third of a possibly fatal dose was contained only in the brain.

"As to the empyema being a possible cause of the fatal outcome, it must be admitted that the debilitated state of the child due to the severe infection has furthered the deleterious action of the boric acid on the child's organism.

"The conclusions drawn from the chemical examination have been confirmed by the clinical symptoms offered by the child."

COMMENT

A consideration of this case leaves no doubt that boric acid can be absorbed from the surface of an empyema cavity covered with a pseudomembrane. Until the patient received the boric acid irrigations his clinical condition was favorable and the picture

of increasing intoxication started only after they were started. It continued after the boric acid had been discontinued.

It has been suggested[12] that in such cases an idiosyncrasy to borates may exist. A review of the literature and our experience in this case furnishes no evidence that such is the situation. It seems more logical to assume that borates absorbed into the tissues (particularly the liver and brain) of any individual or experimental animal up to a toxic level have the power to produce fatal depression and shock.

The concomitant appearance of a toxic, erythematous skin rash occurs so frequently in all instances that this must be regarded as a part of the syndrome in borate intoxication.

Conclusive evidence exists that borates clinically and experimentally have been absorbed through living human skin (even when ulcerated or burned), wound surfaces, mucous membranes of the gastrointestinal tract and mouth, subcutaneous tissues, the venous system, and the pleura in amounts sufficient to produce intoxication. It should be noted that such intoxication often has occurred in situations in which there were large absorptive areas exposed to continuous borate administration. It does not seem that the relative absorptive power of such surfaces has been an important factor.

Interesting indeed are the evidences of local irritation, amounting in some cases to gangrene, produced by the application of borates. The experiments of Hoffman and of Puppe mentioned earlier seem to link up with the similar clinical experiences of Chauvin[10] and of Michon.[22] The former reports a case of gangrenous cystitis in which glycerin was used for postoperative retention. In the discussion of his paper it is mentioned that Carbineau, in 1909, first used boric glycerin 10 to 100 parts for postoperative retention with violent reaction when used in an empty bladder. The latter tabulates twenty-two instances in which boric glycerin instillations successfully reestablished bladder function after periods of postoperative retention. He also warns that boroglycerin in an empty bladder produces hemorrhagic cystitis. One of us (J. F. C.), without definite proof, believes that he has experienced less postoperative hemorrhage after transurethral resection of the prostate when normal saline was substituted for saturated boric acid solution as a bladder irrigant.

In consideration of the predominate opinion that boric acid is an inefficient antiseptic and cannot be shown to have any wound healing properties, there are many substances less dangerous and in all respects more effective. For the irrigation of eyes, ulcers, and infected or necrotic wounds, normal saline is physiologic to the tissues and accomplishes mechanical irrigation equally well. In necrotic, infected wounds or cavities, potassium permanganate in weak solutions (1:10,000) and hydrogen peroxide are safer and better antiseptics because of their oxidizing qualities. With the advent of the local application of the sulfa drugs still more effective bacteriostatic measures are at hand as substitutes for the borates.

CONCLUSIONS

1. A case of fatal borate poisoning resulting from the continuous irrigation of an empyema cavity with saturated boric acid solution is presented.

2. A review of the clinical and experimental literature on borate poisoning given here seems to indicate that boric acid and its related compounds are more dangerous as irrigants and local medicaments than is commonly assumed.

REFERENCES

1. Aikman, John. Strychnine poisoning in children. *J. A. M. A.*, 95: 1661–1665, 1930.
2. Bastedo, W. A. Materia Medica, Pharmacology, and Therapeutics. 2nd ed., pp. 500–501. Philadelphia, 1913. W. B. Saunders Co.
3. Bazin, A. T. Acute boracic acid poisoning. *Canad. M. A. J.*, 14: 419–420, 1924.
4. Bellis, Carroll J. An improved apparatus for tidal drainage of the urinary bladder and empyema cavities. *Surgery*, 8: 791–797, 1940.

5. Best, C. H. Report of a case of boric acid poisoning. *Tr. Chicago Path. Soc.*, 6: 161–168, 1903.
6. Birch, John. Fatal poisoning by borax. *Brit. M. J.*, 1: 177, 1928.
7. Brose, L. D. Death following the external use of powdered boracic acid. *Med. News*, 43: 100–200, 1883.
8. Brown, W. L., Brown, C. P. and Murphy, J. L. Note to the Editor. *J. A. M. A.*, 106: 1221, 1936.
9. Buzza, A. and Cerratola, R. E. Toxic action of boric acid and borate which are employed as conservating and antiseptic substances. *Rev. Asoc. méd. argent.*, 46: 1493, 1932.
10. Chauvin, E. Resection of the pre-sacral nerve for obstinate cystalgic phenomena following an intravesicular injection of glycerine. *J. d'urol.*, 30: 201–205. 1930.
11. Cushny, Arthur R. Pharmacology and Therapeutics. 12th ed., pp. 793–794. Philadelphia, 1940. Lea and Febiger.
12. Dopfer. Ueber einen Todesfall nach Anwendung de Offizinellen Borsalbe einen Brandwunde. *München. med. Wchnschr.*, 52: 763, 1905.
13. Editorial. Boric acid and a hospital accident. *J. A. M. A.*, 88: 841–842, 1927.
14. Forsyth, David. Coeliac disease or boric acid poisoning. *Lancet*, 11: 728–730, 1919.
15. Gissel, Heinrich. A contribution to the toxicity of boric acid. *Zentralbl. f. Chir.*, 60: 1635–1638, 1933.
16. Grafenberg, Ernst. Personal communication to the authors.
17. Kahlenberg, Louis. Passage of boric acid through the skin by osmosis. *J. Biol. Chem.*, 62: 149–156, 1924.
18. Maguire, G. D. Boric acid poisoning. *Practitioner*, 97: 508–581, 1916.
19. McIntyre, A. R. and Burke, C. J. Boric acid poisoning—intravenous in man. *J. Pharmacol.*, 60: 113, 1937.
20. McNally, W. C. and Rust, C. A. The distribution of boric acid in human organs in six deaths due to boric acid poisoning. *J. A. M. A.*, 90: 382–383, 1928.
21. McWalters, J. C. Note on the effects of borax in infants. *Lancet*, 2: 369, 1907.
22. Michon, Louis and Bouvier. Treatment of post-operative retention of urine. *Presse méd.*, 33: 1556–1558, 1925.
23. Molodenkow. Quoted by Tillman. Textbook of Surgery. 2nd. Am. Ed., 1: 160, 1899.
24. Negri, Giovanni. On the distant toxicity of boric acid. *Rassegna di terap. e pat. clin.*, 1: 472–476, 1929.
25. Neuenschwarder, W. Hematuria after instillation of borated glycerin into the bladder. *Schweiz. med. Wchnschr.*, 61: 209, 1931.
26. Peyton, Harry A. and Green, Daniel. Boric acid poisoning. *South. M. J.*, 35: 1286–1288, 1941.
27. Potter, Caryl. A Case of borax poisoning. *J. A. M. A.*, 76: 378, 1921.
28. Sanders, J. H. Boracic acid poisoning. *Brit. M. J.*, 1: 605–606, 1912.
29. Sajons, L. T. de M. and Hundley, J. Warren. Boric Acid, the Cyclopedia of Medicine II: 733–741. Philadelphia, 1936. F. A. Davis & Co.
30. Trumper, Max. Some recent advances in toxicology. *Internat. Clin.*, 40: 233–246, 1930.
31. Wood-Lawall. Acidicum Boricum, United States Dispensatory. ed. 22, p. 21–24. Philadelphia, 1937. J. B. Lippincott Co.
32. Wilson, P. A case of boric acid poisoning. *J. Med. Soc. District of Columbia*, 14: 329–331, 1915.

CONTINUOUS CAUDAL ANESTHESIA*

PRELIMINARY REPORT OF A NEWLY MODIFIED TECHNIC

A. CHARLES POSNER, M.D. AND IRWIN M. BUCH, M.D.
Visiting Obstetrician, Harlem Hospital — Resident Obstetrician, Harlem Hospital
NEW YORK, NEW YORK

THE authors wish to describe a newly modified technic for the administration of continuous caudal anesthesia in obstetrics, as originally reported by Hingson and Edwards.[1]

We have observed three marked disadvantages to the original method: The most important objection is that the physician must administer the anesthetic agent (procaine) to the parturient at regular intervals of thirty to forty minutes. For a busy obstetrician, this technic is impractical, as he can thus care for only a single patient in labor at one time. Second, special apparatus would be needed to make painless labor available to a large portion of the public; this is not feasible in these times. Third, the continual handling of the apparatus each time the medication is injected increases the likelihood of contamination.

By a simple modification of technic which ensures continuous rather than repeated fractional dosage, we believe that we have eliminated these three disadvantages and at the same time made the method safer.

TECHNIC

For the original injection, we follow the method and observe the precautions described by Edwards and Hingson.[1] However, we vary the volume of 2 per cent procaine from 30 to 50 cc. In the early first stage, 30 cc. are sufficient, but during the second stage, 50 cc. are required. An initial injection of more than 50 cc. may result in procaine excitement.

We prefer an ordinary large spinal tap needle to the malleable type. As in the original technic, the skin and subcutaneous tissues are first infiltrated. The skin is pierced about one inch caudad to the sacral hiatus. The spinal needle is allowed to run in the subcutaneous tissue until the point reaches the level of the sacral hiatus. The hillock of the needle is then raised, with resultant lowering of the point. The sacrococcygeal membrane is pierced and the sacral canal entered. The operator next depresses the needle so that it returns to its original direction, almost parallel to the skin, after which he inserts it two inches up the sacral canal. The needle is, therefore, buried up to the hillock, if possible; it is thus anchored and protected.

After insertion, the needle is connected by means of ordinary infusion tubing to a small Kelly flask or similar container. Fifteen minutes after the initial injection, a slow, continuous drip infusion of eight to ten drops (0.5 to 0.6 cc.) of 2 per cent procaine per minute is begun. The patient, therefore, receives the equivalent of "20 cc. every thirty to forty minutes," as recommended by Hingson and Edwards.[1] This dosage may be varied according to the needs of the patient. We have found a dosage of twelve to fourteen drops per minute more satisfactory.

Infusion tubing is readily obtainable in any hospital and the container for the procaine is easily improvised. A small Kelly flask may be employed. For our first case we used the barrel of the syringe employed to fill a Voorhees' bag. We now have an old cylinder, opened at the bottom, originally used thirty years ago, when salvarsan was given by infusion. This cylinder, which is graduated at 10 cc. intervals, allows a

* From the Obstetric Service of Dr. F. A. Kassebohm, Harlem Hospital, New York.

check on the rate of infusion during short intervals of time.

The use of the Lemmon mattress, though not essential, allows the patient greater freedom of motion.

REMARKS

We believe that the modified technic here presented eliminates the three objections to the original method which were stated above. Several patients may now be attended at a single time and watched by any attendant, not necessarily a physician. The apparatus, which is readily improvised, does not necessitate the manufacture of new material. After the apparatus has been set up, it is automatic and does not require frequent handling, with possible contamination.

We also believe this method of administration to be safer than the original. After the initial injection, procaine is slowly replaced at the rate at which it is metabolized. The nerves which are blocked are, therefore, continuously bathed by a constant amount of procaine. Since infusion takes place at such a slow rate, any toxic symptoms will develop so gradually that their development may be checked in the early stages by slowing or stopping the infusion. On the other hand, with the injection of large amounts at intervals and corresponding sharp increases in the rate of absorption, any toxicity occurring after an injection will be sudden and more severe. It is recalled, of course, that the antidotes for procaine are the barbiturates.

At this writing, we have performed during the past four months more than 100 caudal blocks, including single injections and the continuous type. With the technic just described, our type of service at Harlem Hospital should make available about two or three continuous caudal anesthesias a day. We are now preparing a detailed analysis of our results, which we expect to publish in the near future. We are publishing this preliminary report on technic only so that painless labor may be used sooner by more obstetricians and its advantages thus made available at an earlier date to a greater number of expectant mothers.

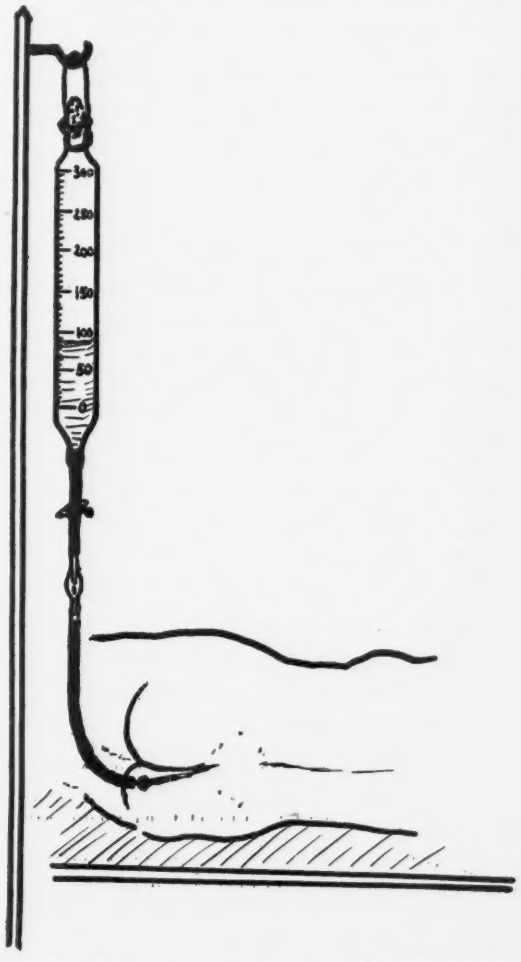


Fig. 1. The graduated container (Salvarsan Tube Vitax No. 4010) hangs from a stand, and is connected by means of ordinary infusion tubing to an ordinary spinal tap needle (B-D Yale-19G-3″) placed in the caudal canal. About fifteen minutes after the initial caudal injection has been effective, the infusion is begun at about twelve drops per minute (45 cc. per hour). The rate of flow is regulated by opening or closing the stop cock on the infusion tubing or varying the height of the container of procaine.

SUMMARY

A modification of the original fractional technic of administering caudal anesthesia, first described by Edwards and Hingson,[1] is reported. After the initial injection, a continuous slow drip infusion is established and continued throughout labor.

This method the authors believe to be safer than the original. By eliminating three disadvantages, namely, frequent injections of the anesthetic, the necessity of special apparatus, and repeated handling of the apparatus, the modified technic becomes more practical and available to a greater portion of the parturient population.

REFERENCE

1. Edwards and Hingson. *Am. J. Surg.*, 37: 459–464, 1942; *J. A. M. A.*, 121: 225–229, 1943.

Versions consist of a turning of the uterus as a whole (flexion being disregarded) about an imaginary axis situated in the upper third of the cervix. Any type of version may be associated with any type of flexion.

CAUDAL ANESTHESIA IN OBSTETRICS

A. C. MIETUS, M.D. AND R. M. MITCHELL, M.D.
MILWAUKEE, WIS. AND JAMAICA, N. Y. MILWAUKEE, WIS. AND BROOKLYN, N. Y.

IN a recent paper,[1] a review of the first 400 caudal anesthetics administered on the obstetrical service of Dr. Albert H. Lahmann at the Milwaukee County Hospital was reported. That series is herein augmented by an additional 400 cases collected from both his service and that of Dr. Thurston S. Welton at Greenpoint Hospital, Brooklyn.

Originally adopted for outlet forceps and episiotomies—of which, incidentally, all our primiparae are given benefit—we have since extended the use of caudal anesthesia to all obstetrical procedures, excepting internal versions, yet including cesarean sections. For the most part the caudal block was administered to the women of this series in the second stage of their labor for the actual delivery of their newborn. Attention is here drawn to the work of Dr. Hingson and Dr. Edwards[2] who have elaborated further on this type of anesthesia and have introduced a technic for the continuous extradural administration of an anesthetic reagent throughout the first stage of labor as well.

The great number of medications and measures of all sorts which have been suggested in the voluminous literature on the subject attest to the fact that no one single stereotyped analgesic or anesthetic is adaptable to all obstetrical cases. Yet in spite of its certain disadvantages, which will be discussed later, it appears that in this perennial quest caudal block most nearly approaches the answer to the problem of alleviating the sufferings of the woman in labor.

The sacral hiatus, which is produced by the embryological failure of development of the spinous process and the laminae of the fifth sacral vertebra, is found to be inconsistent in both size and shape. Although it usually is triangular, with its apex being designated by the fourth sacral spinous process and its base bounded laterally by the sacral cornua, not infrequently it assumes a rhomboid rather than a triangular outline. This observation is noted in those instances in which a tubercle, the rudimentary spinous process of the first coccyx, is prominent. Sometimes the sacral hiatus is nothing more than a narrow slit and only rarely is it found clinically to be as large as the usually described adult's thumbnail. Similarly, the sacrococcygeal membrane of Cathelin is of varying consistency, in some patients being thin and readily penetrable and in others thick and densely fibrous.

Experience has shown that either the lateral decubitus or the knee-elbow position of the patient at the time of injection may be used. The latter is given preference since, although admittedly awkward to the pregnant woman, it retains the symmetry of the arched back; it enlarges the diameters of the sacral hiatus; and, by drawing the overlying integument taut, it exaggerates the anatomical prominences.

The anesthetic used in our clinics is a 2 per cent aqueous solution of metycaine (gamma/2methyl-piperidino/-propyl benzoate hydrochloride). It is a rather stable solution which tolerates sterilization by heat and does not deteriorate on standing. The latent period before the onset of its action is not unduly long and its effect is more enduring than that produced by procaine. No adrenalin is added and it is to this factor that we attribute the scarcity of untoward reactions since none of the vasomotor, respiratory, gastrointestinal or other effects of adrenalin on the autonomic nervous system are produced.

The instrumentarium required consists merely of a 25 cc. syringe and an eighteen gauge spinal puncture needle with its

stylet. With the patient in the knee-elbow position, the operative field is prepared with a reliable skin antiseptic, the sacral hiatus is identified, and the needle is introduced almost perpendicularly to the skin surface. Penetration of the fibrous sacrococcygeal membrane having been effected, as evidenced by the sudden release in the resistance offered, the hub of the needle is depressed so that its long axis lies practically parallel to the long axis of the sacrum, and then advanced a few centimeters to guarantee its presence well in the sacral canal. With an empty syringe, aspiration is attempted. If blood is obtained, the needle must be removed and reinserted lest the solution be introduced directly into the blood stream. On the other hand, if the dural sac has been penetrated, as evidenced by the aspiration of cerebrospinal fluid, the entire process ought be discontinued. The anesthetic is injected slowly. If questioned, the patient will usually admit a "crampy" sensation in one or both legs during the injection. This reaction practically insures the successful infiltration of the sacral canal.

Shortly after the anesthetic is given a dramatic change occurs in the patient. The outcries that accompany each pain are stilled, the exhausting effort to bear down disappears, and the parturient becomes comfortable and co-operative. However, the rhythmic uterine contractions continue painlessly. Anesthesia of the perineum becomes evident several minutes after analgesia is obtained. Beginning in the region of the anus, it extends fanwise: upward over the symphysis pubis, laterally over the inner aspects of the thighs, and backward over the sacral and gluteal regions, the sum effect resulting in a typical "saddle" anesthesia. The height to which anesthesia ascends is almost directly proportional to the volume of anesthetic solution injected. It appears that when larger quantities are used the anesthetic agent dissects its way upward under pressure in the extradural space to bathe the nerves at higher levels in the spinal column. It has been noted, for instance, that although 25 cc. of the solution will ordinarily give saddle anesthesia only, 40 cc. or more will almost invariably give anesthesia to the level of the umbilicus. It is this phenomenon which permits the performance of cesarean sections under caudal block. Simultaneously, the musculature of the pelvic and perineal floors becomes paralyzed. This complete relaxation is a welcome development since it minimizes the incidence of vault tears and facilitates such obstetrical manipulations as the application of forceps, the decomposition of breeches, and manual or instrumental rotations. When small doses of solution are injected, sensory and motor function of the lower limbs are retained. No influence whatsoever on the fetus has been noticed. Furthermore, the third stage of labor is unimpaired. The incidence of retained placenta is not increased. Inasmuch as the myometrium does not lose its tonicity, blood loss is minimal. Sensation recurs inversely to the direction in which it extended. The puerperium is unaffected.

The procedure is not without untoward effects. A sudden transitory drop in blood pressure was noted not infrequently in those patients in whom large single injections, e.g., 60 to 70 cc. were given *en masse*. It was observed also that this fall could be prevented by the preoperative administration of a small dose of ephedrine sulfate intramuscularly. Such transitory episodes as vertigo, jactitation, disorientation, auditory and visual hallucinations, apprehension, or actual generalized clonic convulsions—of too short duration to permit active countermeasures being instituted (the longest lasted two minutes)—occurred in approximately 3 per cent of the series. It should be mentioned here that the incidence of those untoward reactions in patients adequately sedated with barbiturates was nil. Whether this is purely coincidental or whether the barbiturates here counteract toxic effects of metycaine remains to be determined.

There was no instance of morbidity or mortality which could be attributed to the anesthetic procedure. It is not beyond imagination, however, to visualize how an inadvertant massive intrathecal or intravenous injection, rather than extradural, could terminate fatally. It is for this reason that the administration of the reagent must be attended to with extreme caution and punctilious regard. Furthermore, even though it was not observed in this series, there is reason to believe that infection might occur at the site of injection here as it might anywhere else when the integrity of the integument is broken unless scrupulous aseptic care be followed. No residual neurotropic effect was noted in any of the cases. Whether or not some long-delayed undesirable aftermath occurs from the introduction particularly of large quantities of a foreign solution into the extradural space remains a point of conjecture.

Comprising this series of 800 cases, 703 were primiparae and ninety-seven were multiparae. By far and large, the greatest number were delivered by low forceps and episiotomies. There were some midforceps and only one high forceps. As an experiment, several were permitted to deliver spontaneously either with or without the benefit of a perineotomy. There were fifty-four breech deliveries, in thirty of which the breech was broken up and extracted. In numerous instances transverse forceps were applied and in several cases it was necessary to rotate occiput posteriors adopting either the Kielland technic or the Scanzoni maneuver. Twelve women were delivered by cesarean section and in one a Porro section was performed, all entirely under caudal anesthesia. In one case internal podalic version and extraction was attempted but the caudal block was found insufficient and was of necessity augmented by ether. It might be mentioned that in this series of 800 cases were nine women afflicted with severe rheumatic heart disease, four with pulmonary tuberculosis, and twenty-two with toxemias of varying degrees, three of whom had eclampsia. Two of the patients had placenta previa; the first, with a complete type was delivered by cesarean section; the other with a partial previa was delivered by Braxton-Hicks extraction. One abruptio placenta was treated by rupturing the membranes and stimulating uterine contractions with pituitrin. In two instances delivery was facilitated by the use of Duehrssen's incisions.

In 381 of the patients, 25 cc. of 2 per cent metycaine were injected. In 368, 35 to 40 cc. were given and in the remaining fifty-one cases, varying quantities from 10 to 70 cc. were used. It appears that for ordinary obstetrical procedures performed per vaginam under the single dose caudal block, 35 cc. is adequate.

In 554 cases in which this record was kept, the average latent period between the time of administration of the anesthetic and the time anesthesia first became evident about the anal region was 6.9 minutes. The average duration for anesthesia of this series was one hour and twelve minutes.

Ideal results, i.e., anesthesia of the perineum as well as analgesia or the loss of uterine contraction pain, were obtained in 714 cases; in 50 women anesthesia of the perineum developed but the patient either remained aware of contraction pain or complained of pain when traction was applied with the forceps; while in 36 cases the block had failed completely. There is no question but that the failures were, for the most part, due to technical errors on the part of the anesthetist.

CONCLUSIONS

The reintroduction of caudal block into the obstetrical armamentarium presents a method of anesthesia of distinct superiority for operative procedures. Although certainly not a panacea, its objectionable features are outweighed by its advantages. Inasmuch as the technic of administration requires a certain amount of skill, the results obtained are directly proportional to the experience and practice of

the operator. Untoward effects occur but are transient and leave no deleterious sequelae. Caution must be exercised to avoid intrathecal and intravenous instillations of the solution. That infections over the site of injection of the reagent might occur is granted, but none was seen in this series.

In its favor, caudal anesthesia offers relief from pain and relief from the excitability attendant particularly with the excitomotor reflex in the second stage of labor. It permits uterine contractions to continue unaffected. By relaxing the musculature it preserves the perineal and pelvic floors. It does not interfere with the normal mechanisms of labor and is applicable to practically all types. It does not prolong the first stage; it facilitates operative vaginal deliveries in the second stage. It permits complete co-operation of the parturient and it presents no peril to her newborn. The third stage of labor is unaltered and the incidence of postpartum hemorrhage is decreased. The patient is comfortable on her return to bed and her puerperium is unaffected. There is no influence on the subsequent involution of the pelvic organs. The advantages over inhalation anesthesia are obvious: there is no excitement stage, no nausea or vomiting, no danger of explosion; the disturbed acid-base balance, the shock, the dehydration or the postanesthetic pulmonary complications, which so frequently accompany prolonged inhalation anesthesia, are absent. It can be used with relative impunity in patients with cardiac, renal or pulmonary disease.

REFERENCES

1. Lahmann, Albert H. and Mietus, A. C. Caudal anesthesia: its use in obstetrics. *Surg., Gynec. & Obst.*, 74: 63–68, 1942.
2. Hingson, Robert A. and Edwards, Waldo B. Continuous caudal analgesia in obstetrics. *J. A. M. A.*, 121: 225–229, 1943.

AVERTIN ANESTHESIA IN GYNECOLOGY*

REPORT ON A SERIES OF CASES

LIEUT. DANIEL B. DORMAN, M.C., U.S.N.R.
WASHINGTON, D. C.

EVER since Willstatter and Duisberg[1] first published their paper in Germany, in 1923, describing the synthesis of tribromethyl alcohol, avertin has received wide attention and use. Butzengeiger[2] and Eichholtz[3] were the early supporters of its use as an anesthetic in Germany. Among the early published reports of avertin as used in this country are papers by Guttman,[4] Sise,[5] and Nesbit.[6] At first this new anesthetic was used for complete anesthesia, being employed in large dosages. Because of errors in judgment as to dosage and as to choice of patients, several deaths occurred which were blamed on the new drug. This stigma has never been entirely erased from the minds of the profession. But with a general understanding of the dosage to be used and of the dangers to be avoided, avertin has come to be one of our common and reliable anesthetics.

There have been numerous and sometimes varying reports regarding the effects of avertin on the respiration, pulse, blood pressure, and blood chemical levels. In general it may be said that (1) the respiratory rate may be slightly increased, though the respiratory volume is decreased; (2) the pulse is not much affected, with usually a slight increase in rate; (3) the blood pressure often falls, with at times an alarming drop, though this effect seems to vary with the patient; (4) changes in blood levels of the carbon dioxide combining power, nonprotein nitrogen, sugar, etc., are so slight as to be unimportant. Since avertin is detoxified in the liver by combination with glycuronic acid, and is excreted by the kidneys in that form, it is only natural that attention should be focused on these organs for any possible ill effects from the anesthesia. But it is believed that no permanent damage occurs to the normal liver or kidney from avertin as used in the anesthetic dose. The same cannot be said of diseased organs, however, and evidence of severe liver or kidney damage in a patient for operation precludes the use of avertin.

For use in gynecology avertin has been well reported by Peterson and Pierce,[7] Bemis,[8] Reycraft,[9] and others. At Kensington Hospital for Women during the past nine years avertin has been a favorite anesthesia, being used almost routinely for longer gynecological operations. R. B. Schutz[10] first reported a preliminary series of our patients in 1934, at which time 353 cases were included. He emphasized the benefits of using this anesthetic not merely as a basal anesthetic (57 per cent of plastics and 28 per cent of sections needed no supplementary gas or ether), but also to lessen the amount of required inhalation anesthesia. This advantage was directly responsible for a decrease in postoperative complications. The other great claim for its use was the amnesia experienced by the patient, with consequent lack of apprehension and fear. E. A. Schumann[11] made a subsequent report on our series in 1938, when the number of cases had reached 1,100. In a paper discussing various types of anesthesia he described our clinical results with avertin. In addition to confirming the above advantages he emphasized that avertin anesthesia alone, or with a small amount of supplementary nitrous oxide-oxygen mixture, will usually give relaxation that is adequate for gynecological operations. The full surgical anesthesia required for upper abdominal work has no

* From the Kensington Hospital for Women, Philadelphia.

place in gynecology. As Dr. Schumann explained, we usually use morphine-scopolamine "analgesia" alone for vaginal plastic operations in women over fifty-five years of age.

From what has been said above, and from what follows, it may be seen that we do not agree with the position taken by some: "the use of avertin as an anesthetic has been abandoned,"[12] and that now it should be used only as a basal narcotic; nor that it "is not to be used routinely in hospitals."[13] Though our percentage of patients requiring no inhalation anesthesia whatsoever is not as high now as originally reported early in the series, we believe that the small amount of nitrous oxide usually used for a few minutes at the start of the operation to supplement the avertin does not constitute a true "anesthesia."

PRESENT STUDY

The present paper is meant as a further report on our series, which has now reached 1,800 cases. Recently a study was made of ninety-eight consecutive avertin anesthesias with particular attention to (1) the results obtained; (2) the effect on the blood pressure; and (3) the effect on the kidneys. The operations included both vaginal plastics and sections, in white women of varying ages. Patients who were considered bad risks for avertin because of shock, renal disease, etc., were anesthetized by other means. As stated above, women over the age of fifty-five scheduled for plastic operations alone were given morphine-scopolamine "anesthesia" according to our custom; but otherwise cases were not selected.

Results. In Tables I to IV the results obtained are listed as "excellent," "good," "fair," and "poor." Naturally, this is an arbitrary classification, based largely on the amount of time that supplementary anesthesia was required in relation to the length of the operation. Thus the results were called "good" if nitrous oxide mixture was used up to one-third of the operating time; "fair" if used up to two-thirds of the operating time; and "poor" beyond that. But cases classified as "poor" nevertheless received far less inhalation anesthesia than they otherwise would have needed, because of the dilute mixture of nitrous oxide used. Only rarely was ether added.

Our method was as follows: A cleansing soap suds enema was given the night before operation, and repeated in the morning. Three gr. of phenobarbital were administered at bedtime the evening preceding operation. One-quarter gr. of morphine sulphate and $\frac{1}{150}$ gr. of atropine sulphate were the usual preoperative medication, given by hypodermic injection one hour before the scheduled time of operation. We tried to give the avertin twenty to thirty minutes before operation so as to obtain the maximum effect at the time when the incision should be made. This timing of necessity varied considerably in the operations studied, though the time of administration did not seem to have much influence on the result obtained. (Table I.)

TABLE I

Time of Administration Before Operation	Excellent	Good	Fair	Poor	Totals
0–10 min.	2	0	1	1	4
10–20 min.	10	12	11	5	38
20–30 min.	11	8	10	6	35
30–40 min.	4	2	0	4	10
40–60 min.	3	0	1	3	7
61 min.+	0	0	3	1	4
	30	22	26	20	98

The usual dose of avertin used by us (in seventy-seven of the ninety-eight cases studied) is 100 mg. per kilogram of body weight. We do not administer more than 7 cc. of avertin at a time, so patients weighing 155 pounds or more received less than 100 mg. per kilogram, as did a few other patients at the request of certain surgeons on our staff.

However, we had considerably better results in those who received the full dose

of 100 mg. per kilogram than in those with the smaller dosages. (Table II.)

Table II

Dosage of Avertin Used	Excellent	Good	Fair	Poor	Totals
100 mg. per kilo..	26 (34%)	17 (22%)	18 (23%)	16 (21%)	77
Less than 100 mg. per kilo.....	4 (19%)	5 (24%)	8 (38%)	4 (19%)	21
	30	22	26	20	98

The avertin has been given for years by the surgical supervisor, who administers it slowly by rectum after careful preparation and testing, according to the instructions coming with the fluid. When amnesia has developed, the patient is placed on the stretcher and moved to the anesthesia room, where she is watched closely by a nurse until the anesthetist takes over. This period of observation is important, to prevent the "tongue swallowing" which is so apt to follow relaxation of the jaw muscles and abolition of the gag reflex. It is just at the start of the operation, in the case of abdominal sections, that we often administer a dilute mixture of nitrous oxide for a few minutes, while the incision is made and the packing placed in position. In vaginal plastic operations supplementary anesthesia is less often required, as seen in Table III. If it is needed at all, it is usually when perineal repair is begun.

Table III

Type of Operation	Excellent	Good	Fair	Poor	Totals
Vaginal operation	11	2	1	1	15
Abdominal section.....	9	15	18	13	55
Vaginal operation plus abdominal section.....	6	4	6	5	21
Other operations for hernia, breast tumor, etc.....	4	1	1	1	7
	30	22	26	20	98

Postoperatively, the patients are closely observed until the gag reflex returns, though amnesia and sleep usually continue for a number of hours after the return to the ward. Sometimes it is necessary to give a hypodermic of morphia for restlessness, and occasionally respiratory depression or a marked fall in blood pressure are noted at this time. If this becomes alarming, coramine or caffeine may be used for stimulation. The postoperative vomiting and gagging, so common with inhalation anesthesia, are almost completely eliminated; if present at all, they are represented only by a transitory discomfort. Amnesia, for which the women are so thankful, is marked by the question so often asked by the reacting patient, "Is it all over?"

Table IV gives the results obtained as classified by the ages of the patients, which range from thirteen to sixty-two years. From these figures one might argue that avertin is more effective in the older group of patients. But we believe that this is partially explained by the larger percentage of vaginal plastic operations in the older patients; and aside from the personal factor, which cannot be disregarded, results depend largely on (1) the dosage used, and (2) the type of operation.

Table IV

Age of Patient (in Years)	Excellent	Good	Fair	Poor	Totals
10–19	0	1	3	1	5
20–29	5	3	9	5	22
30–39	7	9	8	5	29
40–49	13	7	5	7	32
50+	5	2	1	2	10
	30	22	26	20	98

Blood Pressure. We have noted for some time that there is often a marked fall in blood pressure following avertin anesthesia. Similar falls have not been found following other forms of anesthesia with the same preoperative medication. For this reason the blood pressure was taken postoperatively in this series to determine how

long the pressure remained depressed. In thirty-four of the ninety-eight cases no fall whatever was noted. (Table v.)

Table v

Postoperative Blood Pressure	Total Series	Stimulants Used	Preoperative Blood Pressure 150 or Over
No fall (or slight rise)	34	0	0
Fall occurred	64	2	7
Normal postoperatively (Within 10 mm.)	14	0	0
Normal after 3 hours (Within 10 mm.)	9	0	1
Normal after 8 hours (Within 10 mm.)	14	0	0
Slightly low at 8 hrs. (10–40 mm. low)	21	1	5
Very low at 8 hrs. (over 25 mm. low and below 100 mm.)	2	1	1
Not recorded at 8 hrs.; low at 3 hrs.	4	0	0
Totals	98	2	7

In the remaining sixty-four cases, other factors such as surgical shock may have played a part. But resuscitation (coramine or intravenous therapy) was used only twice in the series; and in only two cases in which the blood pressure was recorded eight hours after operation, was the pressure found to be very low. Seven hypertensive patients (with a preoperative systolic blood pressure of 150 mm. of mercury or more) were included in our series, as no casts were present in their preoperative urines, which showed either no albumin or a faint trace. It is noted in Table v that all of these patients had a fall in blood pressure, the majority of them for a considerable length of time. This has been our experience previously, and though we believe that avertin may be given safely in such patients, a marked fall in blood pressure is to be expected.

Listed below are the blood pressure readings of the five patients in the series who showed the greatest fall. (Table vi.) As noted above, this is far from the usual experience.

Urinary Findings. We refrained from giving avertin to patients who showed microscopic evidence of renal disease or much albumin in the preoperative urine specimen. Though both albumin and casts were often present in postoperative urine samples, we have found them also when other anesthetics have been used, such as ether or even morphine-scopolamine "anesthesia" alone. These pathological danger signs seem to be caused merely by a temporary condition, to which probably the shock of operation also contributes. The commonest urinary finding of note following operations under avertin was casts, either with less than a faint trace, or 2+, of albumin (forty-three cases) or with considerable albumin (ten cases). These findings, however, did not persist usually

TABLE VI

Age of Patient	Type of Operation	Duration of Operation	Blood Pressures						
			On Adm.	A.M.	Pre-op.	Post-op.	3 Hrs.	8 Hrs.	Comments
41	Appendectomy	25 min.	110/70	122/80	58/40	70/48	76/42	84/54	Apprehensive
52	Simple mastectomy	48 min.	170/90	126/72	.....	54/38	84/52	105/70	Coramine given postoperatively
45	D. & c., cervical amputation, perin'rhaphy	36 min.	159/84	176/78	.....	65/40	92/60	98/66	
44	Supravag. hysterectomy, bilat. salp.-oophorectomy.	100 min.	.....	106/58	.....	55/45?	55/45	80/54	P.I.D.; surg. shock, i.v. fluids, Coramine
50	Appendectomy	61 min.	130/80	134/86	66/52	76/52	84/62	114/72	Retrocecal appendix

even to the third day; and by the tenth postoperative day the kidneys were apparently again functioning normally. Others, such as Pangman,[14] have also compared postoperative urine studies in avertin with controls. Our findings here support the general belief that avertin causes no permanent damage to the normal kidney. Moreover, from time to time a patient has required a second operation, with avertin repeated, and no ill effects were observed.

DEATHS

There was only one death among the ninety-eight cases studied above. This was caused by pulmonary embolus on the tenth postoperative day. But in our total series of 1,800 cases, we have had twenty-one deaths. The primary causes of death have been listed in Table VII. The first three causes of death listed—peritonitis, postoperative intestinal obstruction and embolus—include thirteen cases. Avertin could not possibly have been blamed for these casualties. A brief review of the other eight deaths follows:

Table VII

Cause of Death	No. of Deaths
Peritonitis	8
Postoperative intestinal obstruction	2
Pulmonary or cardiac embolus	3
Uremia	4
Diabetes with coma; postoperative nephritis	1
Anuria (both ureters ligated)	1
Rheumatic heart disease; shock	1
Postoperative thyroid storm; cardiac failure	1
Total	21

Case I. Mrs. C. F., age forty-one, was admitted with a third degree prolapse of the uterus and marked hypertrophy of the cervix. The patient was obese and weighed 246 pounds. Her blood pressure was 154/70; preoperative urine showed 2+ albumin with occasional casts. Vaginal hysterectomy was performed under avertin two days after admission. Because of oliguria, blood urea and urea nitrogen were taken on her first postoperative day, but these were normal. Urinary excretion returned, but with persistent casts. The course was satisfactory until her twelfth postoperative day, when vaginal bleeding followed an enema. Two days later secondary suture of the anterior suture line was done under nitrous oxide anesthesia. Following the bleeding, hemoglobin had fallen to 50 per cent and red blood cells to 3,170,000. Oliguria again resulted, with passage of only 14 ounces of urine in forty-eight hours, despite hypertonic glucose by vein. The patient expired on her sixteenth (and second) postoperative day. No autopsy was obtained. Though she was signed out as *uremia* and terminal cardiac failure, blood urea on the day of death was 17.8 mg. per cent and urea nitrogen 8.3 mg. per cent. Avertin blame was doubtful.

Case II. Mrs. E. M., age fifty-five, was admitted for supravaginal hysterectomy and bilateral salpingo-oophorectomy. She weighed 152 pounds. Blood pressure was 148/90; preoperative urine was normal. Following operation oliguria occurred (13 to 20 ounces daily) despite parenteral fluids. Urine showed persistent casts and 2+ albumin. On her second day she complained of abdominal pain; considerable distention developed and grew worse. On her fourth postoperative day blood urea was 112 mg. per cent and urea nitrogen 52 mg. per cent. Râles were heard at her lung bases, without consolidation. Death occurred on the following day, after respirations became rapid and labored. Cause of death was *uremia*. No autopsy was obtained. Avertin probably was contributory to death.

Case III. Mrs. M. J., age sixty, was admitted for repair of incisional hernia. She weighed 148 pounds. Blood pressure was 146/92; preoperative urine was normal; blood urea 42, urea nitrogen 20 mg. per cent. Seven cc. of avertin were given (104 mg. per kilo.). Postoperatively dyspnea resulted, apparently from hypostatic congestion. The amount of urine excreted seemed adequate, though there were casts persisting up to the time of her death, with only 1+ albumin. Dyspnea increased without adequate signs of pneumonia to explain her condition. She lapsed into deepening unconsciousness and died on her tenth postoperative day. Autopsy was limited to the abdomen, but showed nephrosclerosis. Cause of death was *uremia* and hypostatic pneumonia. Avertin probably was contributory to death.

Case IV. Mrs. A. P., age fifty-nine, was admitted for radical mastectomy because of carcinoma present for two years previously; the lymph nodes were involved. She weighed 182 pounds. Blood pressure was 152/92; urine showed many casts, with 1+ albumin. Seven cc.

of avertin were given (84 mg. per kilo.). Following the operation, which took forty-five minutes, the patient never fully regained consciousness. Her blood pressure remained low, 65/40 and 74/52, and she excreted very small amounts of urine, despite parenteral fluids—3½ and 5 ounces in twenty-four hours respectively. The urine showed many casts, with considerable albumin (2^+ and 3^+). The patient died on her second postoperative day. The cause of death was nephritis and *uremia*. Autopsy was not obtained. Avertin probably was contributory to death.

Case v. Miss R. E., age sixty-seven, was admitted with carcinoma of the transverse colon. She weighed 134 pounds. Blood pressure was 155/90; preoperative urine was normal. blood sugar 165, urea nitrogen 15, mg. per cent; urea clearance 91 per cent. She was given 6 cc. of avertin (100 mg. per kilo.). The carcinoma was resected with the terminal ileum, ascending colon, and hepatic flexure; a side-to-side ileocolostomy was performed; operating time was two hours and twenty-five minutes. Postoperatively the respiratory rate was depressed; blood pressure was 110/90. Diabetic coma was suspected, with blood sugar 400, urea 111, and urea nitrogen 52 mg. per cent. Intravenous glucose and insulin were given, with improvement (sugar 210, urea 90, urea nitrogen 42 mg. per cent). Urine showed less than 1 per cent sugar and no acetone, but persistent casts and 2^+ albumin were present. Urinary output was fair. Her fever rose to 106.5°F. terminally on her third postoperative day, and her pulse rate to 160; blood sugar was 325 mg. per cent. A complete autopsy was not obtained, but examination of abdomen showed no peritonitis or leakage from the bowel. Cause of death was listed as *diabetes with coma* and *postoperative nephritis*. Avertin probably was contributory to death.

Case vi. Mrs. E. S., age forty-six, was admitted with a large fibroid uterus. The patient was obese. Because of 30 per cent hemoglobin and 1,850,000 red blood cells three transfusions were given before operation. Her heart was enlarged with a loud systolic murmur; blood pressure was 126/60; urine showed 2^+ albumin, but was contaminated with blood. Despite three transfusions, vaginal bleeding continued and panhysterectomy was done six days after admission; hemoglobin at that time was 42 per cent and red blood cells 2,420,000. Seven cc. of avertin were used. Following operation the patient remained semiconscious and moaned with back pain. Only 1½ ounces of urine were obtained by catheterization, showing many casts and 3^+ and 2^+ albumin. Blood urea was 96, urea nitrogen 45 mg. per cent. On the day following operation, she was returned to the operating room, where she died on the table under ether anesthesia. The right ureter had been divided and the left ureter was ligated in a mass of tissue at the operative site. Cause of death *anuria* from division and ligation of ureters, myocardial degeneration and anemia. No autopsy was obtained. Avertin blame was doubtful.

Case vii. Mrs. A. T., age sixty, was admitted with a gastric ulcer and stomach retention. She weighed 157 pounds. Blood pressure was 120/90, hemoglobin 50 per cent and there were 2,750,000 red blood cells; rheumatic mitral disease, compensated. Preoperative urine was normal; blood urea was 37, urea nitrogen 17, mg. per cent. Four days after admission, posterior gastrojejunostomy was done under avertin-nitrous oxide anesthesia. Six and eight-tenths cc. of avertin were used (96 mg. per kilo.). Pulmonary edema followed postoperative intravenous injection of 10 per cent glucose; pulse was 144 and thready; blood pressure was 70/40. Respirations remained rapid, and the patient died twelve hours postoperatively. No autopsy was obtained. Cause of death was *rheumatic heart disease* and shock. Avertin blame was doubtful.

Case viii. Mrs. E. S., age fifty-three, was admitted for hysterectomy because of fibroids. She weighed 115 pounds. Blood pressure was 180/90; pulse 92 to 100 preoperatively; there was no palpable thyroid enlargement; the heart was normal. Preoperative urine showed 2^+ albumin and many white blood cells (voided specimen). Blood urea was 24, urea nitrogen 11, sugar 105 mg. per cent. Five and two-tenths cc. of avertin (100 mg. per kilo.) were given for operation on day after admission. Chronic salpingitis and pyohydrosalpinx complicated the procedure. Her pulse reached 160, and respirations 28, at the end of the operation. The pulse remained rapid, despite therapy, and fever reached 103°F. the first night and 106°F. the second night. The patient was restless and her extremities were clammy. Urine showed many casts and 2^+ albumin; the output was adequate. Transfusions and iodine therapy supplemented intravenous fluids and digalen. On the third postoperative day, as fever

reached 106°F. again (by axilla), signs of cardiac failure appeared. The pulse, which had never fallen below 124 since operation, again rose to 160. Blood pressure was 170/90. There was no pain and only slight distention. No apparent pelvic abscess was present, and only serosanguineous drainage from wound drain occurred. Fever reached 109°F. terminally, as the patient died on her fourth postoperative day. Autopsy was not obtained. Cause of death was *thyroid storm*. Avertin blame was doubtful.

Of the eight deaths described above, there were only four cases in which avertin anesthesia probably contributed to the death; and in none of these cases was a complete autopsy granted to confirm the clinical opinion of the cause of death. Before avertin is blamed too harshly, it must be remembered that any other general anesthesia might have produced the same results. All four of our patients died with renal complications between the second and the tenth days postoperatively; but we have had no deaths from respiratory failure or shock alone, caused by avertin.

COMMENTS

Contraindications. Considerable renal damage is our commonest contraindication to the use of avertin. We believe that this decision is wise in view of the renal method of excretion of avertin. We also dislike the use of avertin in the presence of shock with anemia (as in ruptured tubal pregnancy), because of the danger in decreased oxygen-carrying capacity with possible respiratory or circulatory depression. As previously stated, we prefer morphine-scopolamine anesthesia alone for vaginal plastic work in older patients; but we do not hesitate to use avertin for sections in older women if the kidneys are in good condition. Liver disease, colitis, and advanced pulmonary disease are uncommon among our patients, but they have been described also as contraindications. However, we have often performed a hemorrhoidectomy at the end of a plastic operation under avertin, after dilatation of the rectal sphincter and evacuation of the rectum. Our experience with avertin in obstetrics has been disappointing, with a delay in labor resulting from a period when pains practically cease and the patient becomes unmanageable.

Complications. Respiratory depression and "shock" are the two commonest complications. But we have found serious respiratory depression only occasionally; and a drop in blood pressure is not often accompanied by rapid pulse and other signs of true surgical shock. Such instances invariably respond to prompt therapy. Swallowing of the tongue, accompanied by loss of the gag reflex, and subsequent obstruction to respiration, must be avoided.

Advantages. The advantages of this type of anesthesia fall into three periods. Preoperatively, the patient is spared the consciousness of being brought to the operating room. This mental shock, so dreaded by the apprehensive patient, is entirely eliminated, as the fluid is given in bed by a method made familiar by the previous administration of enemas. During the operation, if supplementary anesthesia is necessary, the stormy second stage is avoided; and only a fraction of the usual inhalation anesthesia is used. Because of this fact, avertin is practicable in mild cardiac and pulmonary complications, with caution observed concerning the loss of the cough reflex. This advantage is also directly responsible for the postoperative advantages of avertin: less perspiration and, therefore, less thirst; less vomiting, and quicker oral intake of fluids; and less atelectasis and pneumonia. The whole postoperative course is apt to be smoother and more uneventful.

Disadvantages. Though we believe that all objections are overbalanced by its advantages, avertin does have some disadvantages. The length of the induction period has been circumvented by our arrangements for administration already described. Likewise we are not disturbed by the slow excretion of the anesthetic; we rather appreciate the postoperative rest and amnesia afforded the woman The lack

of control of the drug following administration, and the "narrow margin of safety" cannot be disregarded; but consideration of the recognized dosage and of the physical condition of the patient will safeguard against errors. As to individual variations in susceptibility to avertin, more inhalation anesthesia can always be given if the desired relaxation is not obtained; but complete surgical anesthesia is rarely necessary in gynecological operations.

SUMMARY

A series of 1,800 cases of avertin anesthesia is reported, the large majority of operations being gynecological.

Ninety-eight consecutive cases are studied in detail, with particular attention to results obtained, effect on the blood pressure and urinary findings.

Twenty-one deaths in the total series of cases are reviewed.

As a result of our experience, we believe that the advantages of avertin far outweigh its disadvantages; and we agree with Peterson and Pierce[7] in their conclusion that "avertin more nearly approaches the ideal anesthetic than any other drug which has been employed in the clinic."

The opinions or assertions contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the Naval service at large.

REFERENCES

1. Willstatter, R. and Duisberg, W. *Beitr. d. deutsch chem. Gesellsch.*, 54: 2283, 1923.
2. Butzengeiger, O. *Deutsche med. Wchnschr.*, 53: 712, 1927.
3. Eichholtz, F. *Deutsche med. Wchnschr.*, 53: 710, 1927.
4. Guttman, J. R. *Ann. Surg.*, 90: 407, 1929.
5. Sise, L. F. *Surg. Clin. North America*, 9: 1381, 1929.
6. Nesbit, W. M. *Wisconsin M. J.*, 28: 589, 1929.
7. Peterson, R. and Pierce, J. M. *Surg., Gynec. & Obst.*, 55: 191, 1932.
8. Bemis, G. G. *Am. J. Obst. & Gynec.*, 25: 677, 1933.
9. Reycraft, J. L. *Am. J. Obst. & Gynec.*, 30: 332, 1935.
10. Schutz, R. B. *Am. J. Obst. & Gynec.*, 28: 439, 1934.
11. Schumann, E. A. *Med. Rec.*, 147: 26, 1938.
12. Kaye, G. *Australian & New Zealand J. Surg.*, 3: 235, 1934.
13. Blomfield, J. *Proc. Roy. Soc. Med., London*, 23: 99, 1929.
14. Pangman, W. J. *Southwest. Med.*, 22: 6, 1938.

BACILLUS PROTEUS OX19 AGGLUTINATED BY THE SERUM OF PREGNANT WOMEN*

PRELIMINARY REPORT

I. GRATCH, M.D.
Hahnemann Medical College and Hospital
PHILADELPHIA, PENNSYLVANIA

DURING a series of researches that were conducted at the suggestion of a distinguished colleague for the purpose of making an epidemiological survey to detect, if possible, the incidence of rickettsia diseases (typhus, Rocky Mountain Spotted Fever, etc.) in the Philadelphia area, by means of an agglutination test, using as antigen the different strains of Bacillus proteus OX, an interesting fact appeared. The author noticed the exceptional frequency of a positive agglutination test, particularly with the strain Proteus OX19, in cases of sera from pregnant women, who had absolutely negative histories, so far as previous typhus or other rickettsial diseases were concerned.

This striking fact led the writer to abandon, temporarily at least, his epidemiological investigation, in order to consider the usefulness of a separate study capable of demonstrating whether the sera of pregnant women do or do not consistently agglutinate the different strains of Proteus OX.

After having tried in a few preliminary experiments the strains OX_2 and OXK, attention was concentrated on the strain OX19, because this one seemed to give the most reliable results.

For preliminary researches, the suspension of Proteus OX19 was used as antigen. The technic adopted in performing this test is very simple. A drop of the serum to be tested is pipetted with a small pipette (for example, 1 cc. pipette or the ordinary capillary-pipette) on to an ordinary slide. To this is added a drop of Proteus OX19 antigen, which was shaken gently before using. The mixture of serum and antigen thus prepared on the slide is mixed thoroughly with a separate toothpick or with the tip of the capillary pipette. For each test a fresh pipette not previously in contact with another serum, is used. Each day a control is set up on a glass slide, using, instead of serum, a drop of normal salt solution. After mixing, the glass slide is gently rocked back and forth ten to twenty times, and during this rocking the slide is studied carefully for the appearance of the clumping. In cases in which a marked agglutination will occur, the clumping is observed, with the naked eye, after ten to thirty seconds; seldom is it necessary to wait as long as one or two minutes. The longer times were required especially in rare so-called "false positives." Usually it was not necessary to observe the glass slide under the microscope (with low power); only in a few doubtful cases, particularly in cases of a slow belated agglutination in the "false positive" tests, did we make the observation with the aid of the microscope, in order to check on the appearance of clumping. In several cases of very early pregnancy, in which we had a very slow clumping, we were compelled to use the microscope in order to determine whether the clumping of the organisms did occur; a week or so later, however, as pregnancy advanced, the sera of the same patients agglutinated the Proteus OX19 in about twenty seconds and the agglutination was easily visible with the naked eye.

The results of 1,212 tests made on the sera of men and women are summarized in Table 1.

* Aided by Constantine Hering Fund of the Hahnemann Medical College of Philadelphia.

TABLE I
ANALYSIS OF 1212 TESTS ON SERA OF MEN AND WOMEN

	Men		Women	
Total sera examined	412		800	
Negative results	390		288	(nonpregnant)
Positive results	22	Tumor—2 Vaccinated with Bacillus proteus vulgaris—2 Unknown cause—18	512	Pregnant—505 Nonpregnant but with tumors—7

Note that the test was 100 per cent positive in pregnant women, and that positive tests for nonpregnant women were obtained only in cases with certain malignant tumors.

Of the 412 sera taken from men, 390 gave a negative agglutination test, while twenty-two gave a positive test. Of these twenty-two positive cases in men, two were affected with carcinoma; two had previously received injections of an autogenous vaccine prepared from a strain of Bacillus proteus vulgaris isolated from their feces. We have thus far not been able to complete a detailed and reliable enough investigation in order to reach a satisfactory explanation for the positive results obtained for the eighteen men listed in the Table I as "unknown cause."

The group of 800 women gave 288 negative tests (in nonpregnant women) and 512 positive; of these 512 cases, only seven were not pregnant, *but all seven (as also in the cases of the two men mentioned above) were affected with a malignant tumor.* This fact, incidentally, is of an interest and we plan in the future to investigate this problem more exhaustively, namely, the agglutination of Proteus OX19 by blood sera of patients affected with malignant tumor, in order to obtain statistical data, which would enable us to reach some reliable conclusions as to the value of this test in the diagnosis of tumors.

All the 505 pregnant women, i.e., 100 per cent of the pregnant cases examined, gave a positive test.

We wished also to determine the dilution titer of the sera which agglutinated the different strains OX of the Bacillus proteus. After a few experiments with other strains, which gave no clear-cut results, we decided to use only the strain OX19. We followed the standard technic as shown in Table II. For each specimen of blood serum we used ten dilutions in a series of ten ordinary agglutination tubes, plus one (the eleventh) tube for control. In each tube, with the usual technic, we placed sterile normal salt solution, plus a suspension in salt solution of Proteus OX19 (obtained from the "American type culture collection"), plus the serum to test (diluted according to standard technic); in the eleventh (the control) there was of course no serum, but only the salt solution and the suspension of the Proteus OX19. The suspension of the latter was always adjusted roughly to the same bacterial density by inspection of the turbidity. After incubation at 37°C. for two hours, the agglutination tubes were placed in a refrigerator overnight, and the following morning the results were read.

Owing to lack of time, the titer of the agglutinins was not determined for each of the 505 positive cases. Such a more complete and detailed study is planned for the future. We did, however, determine the titer for some fifty sera; and the titer which we found ranged between a minimum of 1:256 (Case of Mrs. I.) and a maximum of 1:1024 (Case M. Y.). (Table II.)

For the same reason we could not establish the stage of pregnancy in which our test first begins to yield a positive result, nor could we determine how soon after delivery (or after abortion) the test becomes negative. There are important aspects of this test which we plan to investigate more exhaustively. But we have at least presumptive evidence that the positive test appears at a very early stage of pregnancy. Thus, for example, in Case No. 1201 (M. Y.) the diagnosis of pregnancy was difficult and complicated because of some unusual features. The patient was a twelve year old girl, and our test was weakly positive, whereas the Friedman pregnancy test was negative. Twelve days later, when the Friedman test became positive, we repeated our test with a fresh specimen of blood serum and then our test

showed a strongly positive result and agglutinated even at a dilution of 1:1024. (Table II.)

TABLE II

	1	2	3	4	5	6	7	8	9	10	11 Control
	1:4	1:8	1:16	1:32	1:64	1:128	1:256	1:512	1:1024	1:2048	
Case No. 140	+++	+++	++	++	+	+	+	+	−	−	−
Case No. 161	+++	+++	+++	++	+	+	+	±	−	−	−
Case No. 162	+++	+++	+++	+++	++	+	+	±	−	−	−
Case No. 520	+++	+++	+++	++	+	+	+	+	±	−	−
Case Mrs. E. C.	+++	+++	+++	++	+	+	+	±	−	−	−
Case Mrs. I	+++	+++	+++	++	+	+	+	−	−	−	−
Case M. Y. No. 1201	+++	+++	+++	+++	+++	++	++	+	+	−	−
Case No. 977	+++	+++	++	+	+	+	+	−	−	−	−

Although we obtained 100 per cent positive reactions in all cases of pregnancy tested, we do not claim to have elaborated a new pregnancy test, or a better test than those that already exist and are used routinely. The accumulation of further data would place the test on a firmer statistical basis. For this reason we hope that other investigators will further extend the number of cases studied by this method for the diagnosis of pregnancy. Additional work is necessary also to determine the limitations of the test, the conditions which may increase or decrease the intensity of the reaction, and to inquire into the numerous problems which suggest themselves as a result of this initial investigation.

On the other hand, if this test is confirmed and its utility checked by other workers it would be of value as a test possessing certain material advantages over the best tests that exist today for the laboratory diagnosis of pregnancy, such as the Friedman test[1,2] or its modifications by Reinhart and Scott[3,4] or by Schneider.[5] This could be so because, technically at least, our test is a simple, quick and easy one, utilizing a technic which does not require a highly specialized training, and can be performed in any medical office or dispensary, without calling for special apparatus, and may be carried out in the office of the physician while he continues his examination of the patient.

In certain cases our test could supplement the Friedman test, namely, in case of a "doubtful" Friedman test which happened, for example, in our Case No. 1201 (M. Y.) in which the Friedman test was negative, whereas our test was positive.

An obstacle which certainly will handicap the routine use of our test presents itself in the shape of the so-called "false positive." This is due to the fact that weak cross agglutinations occur with some sera, because strains of Proteus are capable of causing infections of the urinary tract and of the ear[6,7] and also infections of the gastrointestinal tract[8] and so give rise to agglutinins for Proteus. This may possibly explain the occurrence of our "false positives" in the group of eighteen men.

Remaining also is the fact that our test gives a positive reaction in certain cases of malignant tumor (carcinoma). This is suggestive of the possible use of the test as an aid in diagnosing cases of malignancy. Yet at the same time it renders our test somewhat less "specific" for the diagnosis of pregnancy. It is also recognized that other pregnancy tests as well are complicated by conditions which give rise to "false positives," e.g., the Aschheim-Zondek test is positive in cases of hydatiform mole and in chorionepithelioma;[9] with Friedman and Schneider tests "false positives have been obtained in association

with tuberculosis of the adnexae, with persistent corpus luteum cysts combined with amenorrhea, hyperthyroidism and certain diseases of the hypophysis."[10] Teratomas, especially in the gonads, may give a false positive reaction in both men and women.[10,11]

Therefore, no matter which test we use in making a diagnosis of pregnancy today, we cannot dispense with the clinical and physical diagnosis.

In any case, the fact that the blood sera of 505 pregnant women, without exception, agglutinated the Proteus OX19, is of sufficient importance from a scientific standpoint to challenge the curiosity not only of the immunologist but also of students in related fields: physiologists, obstetricians, endocrinologists, and even epidemiologists. In fact, in the case of an epidemiological survey in any given area having to do with the incidence of the rickettsia diseases, we have to be aware of the factors discussed above which would necessarily complicate the results of the survey. A positive result in testing for the presence of agglutinins for Proteus OX19 in certain sera might not necessarily mean the prior existence of a rickettsia infection, but might also indicate pregnancy, a malignancy, or other conditions alluded to earlier in this paper.

SUMMARY

Examinations were made of 1,212 sera of men and women for the agglutination of Proteus OX19. Of the 412 sera taken from men, 390 did not agglutinate, while twenty-two did agglutinate the Proteus OX19.

In the group of 800 sera from women, 288 nonpregnant women gave negative tests, whereas 512 sera gave positive tests. Of these 512 cases, only seven women were not pregnant, but all seven were affected with a malignant tumor. *The remaining 505 sera were taken from pregnant women, and all gave positive agglutination tests for Proteus OX19.*

The value of the test for the routine diagnosis of pregnancy is discussed, as well as the possible reasons for the positive results which were encountered in the cases of malignancy and other complications.

REFERENCES

1. Friedman, M. H. Mechanism of ovulation in the rabbit. II. Ovulation produced by the injection of urine from pregnant women. *Am. J. Physiol.*, 90: 617–622, 1929.
2. Friedman and Lapham. *Am. J. Obst. & Gynec.*, 21: 405, 1931.
3. Reinhart, H. L. and Scott, E. The hormone test for pregnancy. *Am. J. Clin. Path.*, 1: 113–126, 1931.
4. Reinhart, H. L. The results of two years' experience with the Friedman test. *Am. J. Clin. Path.*, 3: 9–15, 1933.
5. Schneider, P. F. A hormone test of early pregnancy. *Surg., Gynec. & Obst.*, 52: 50–60, 1931.
6. Welch, H. and Poole, A. K. *J. Bact.*, 28: 523, 1934.
7. Welch, H., Mickle, F. L. and Borman, E. K. *Am. J. Pub. Health*, 24: 1157, 1934.
8. Azzi, A. Microbiologia e Immunologia. Vol. 2, p. 660. Milan, 1938. Casa Editrice Dr. F. Vallardi, Milan.
9. Aschheim, S. The early diagnosis of pregnancy, chorion-epithelioma, and hydatiform mole by the Aschheim-Zondek test. *Am. J. Obst. & Gynec.*, 19: 335–343, 1930.
10. Allen, Banforth, Doisy. Sex and Internal Secretions. 2nd ed., pp. 1297–1301. Baltimore, 1939. Williams and Wilkins Company.
11. Ferguson, R. S. Pathologic physiology of teratoma testis. *J. A. M. A.*, 101: 1267, 1933. (Abstracted from *American J. of Cancer*, N. Y.; 18: 269, 1933.)

COMPARISON OF TISSUE REACTIONS FROM NEW SUTURES*

OCTAVUS P. LARGE, M.D.
PHILADELPHIA, PENNSYLVANIA

THE development of metallic sutures through the centuries is very interesting. In the sixteenth century Hieronymus, a teacher of Sir Wm. Harvey, wrote of the advantages of gold wire in surgical practice for ligation of vessels. Henry S. Levert,[25] of Alabama, in 1829, reported a series of twenty-one experiments upon dogs ligating the carotid and femoral vessels with lead, platinum, silver, waxed silk and gum elastic resin. Of these experiments the metallic sutures showed the least reaction. Some years before, Dr. Physick had suggested lead as suture material because of the minimal tissue reaction about missiles implanted in the tissues of the body resulting from war wounds.

J. P. Mettauer, of Virginia, aware of the reports and suggestions of Levert and Physick, closed vesicovaginal fistulas using lead wire in six cases. Mettauer's instruments and wire may be seen in the Mutter Museum in Philadelphia. The real pioneer use of metallic sutures should be credited to J. Marion Sims[30] who disheartened and "studiously avoiding," after many trials and failures to close vesicovaginal fistulas, turned to the use of silver wire. On November 14, 1848, with the aid of jeweller, blacksmith, and dentist he assembled the instruments to perform his first successful closure of a vesicovaginal fistula upon a Negro patient who had had thirty previous attempts. His description of the cure of this patient imparts his real joy and enthusiasm. He converted a small house into a hospital for these unfortunate patients. It is said he closed over 200 vesicovaginal fistulas.

J. Y. Simpson, of Edinburgh, in 1858, continued the use of metallic sutures, after having attended a lecture given by Dr. Bozeman (Assistant of Sims) relating the successes with silver sutures.

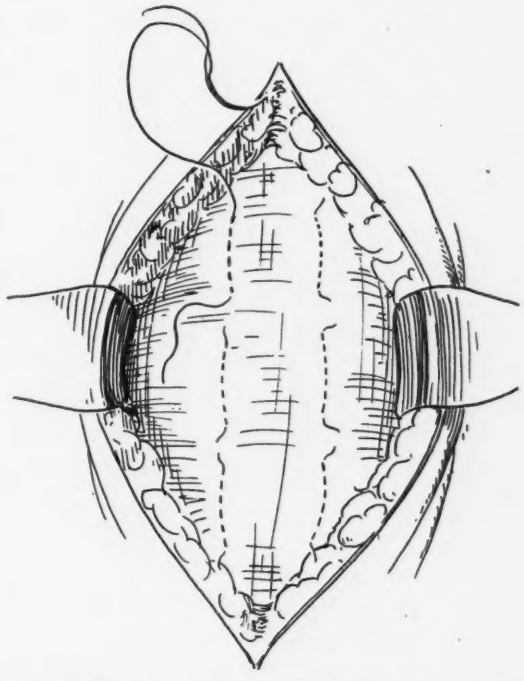


FIG. 1. Illustrates placement of sutures in rectus muscle of a dog. Note there is no constriction of tissues.

In 1904, Dr. W. W. Babcock,[3] following Bartlett,[6] first attempted to close large defects in the abdominal walls by imbedding a fine silver wire filagree. Babcock, finding that the silver filagree became fragmented from movements of the body, introduced (1916) a fine sterling silver chain as employed by jewelers. In 1932, Babcock turned to alloy stainless steel wire which proved to be superior to silver wire. At first it was implanted in the skin and allowed to remain for weeks to note the reaction. The surprising absence of necrosis or suppuration encouraged Babcock

* From the Department of Surgery, Temple University Hospital, Philadelphia.

to use it as a buried suture, where it has surpassed any previous absorbable or nonabsorbable sutures.

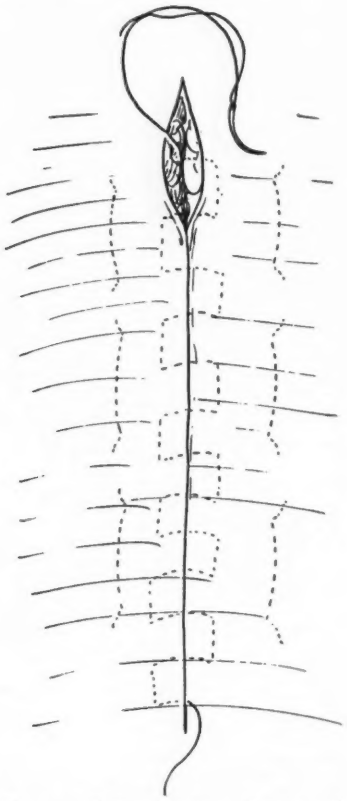


Fig. 2. Subcuticular closure of abdominal skin.

In an effort to be impartial in judging the most ideal suture for general use, the research department* for the past four years, has been comparing and testing new sutures. Preston, in 1939, reported his results in a comparison of the tensile strength of wounds united with wire and other commonly used sutures. He showed the superiority of the tensile strength of wounds closed with the stainless steel all wire technic. My efforts have been confined to the microscopic comparison of alloy steel wire with other sutures.

Clinical experiences gained by observing skin reactions from various sutures in over one-hundred patients, and in reopened abdominal wounds at varying periods of time, have prompted further animal experimentation and microscopic study. The

* Department of Surgical Research, Temple University Hospital.

degree and type of reaction is influenced by many factors: (1) Number and type of organisms present at the time of the suturing; (2) vascularity: an organ or tissue with impaired blood supply either from pathologic process or from constricting sutures or ligatures will naturally show marked reactions; (3) nutrition: weak and debilitated patients with long standing infections, systemic disease, avitaminosis and hypoproteinemia may show delayed healing. The influence of the general systemic condition of the patient upon healing has been very definitely shown by the researches upon hypoproteinemia and vitamin C; (4) foreign bodies other than sutures will prevent normal wound healing and finally allow organisms to invade the subcutaneous tissues and proliferate, causing infection and suppuration. Blood, serum, and bile, when permitted to diffuse through tissues, act as culture media and prevent accurate co-aptation of the wound edges. Hemostasis favors primary healing, especially if the tissues are potentially infected. Nevertheless, these local and systemic factors are too often believed

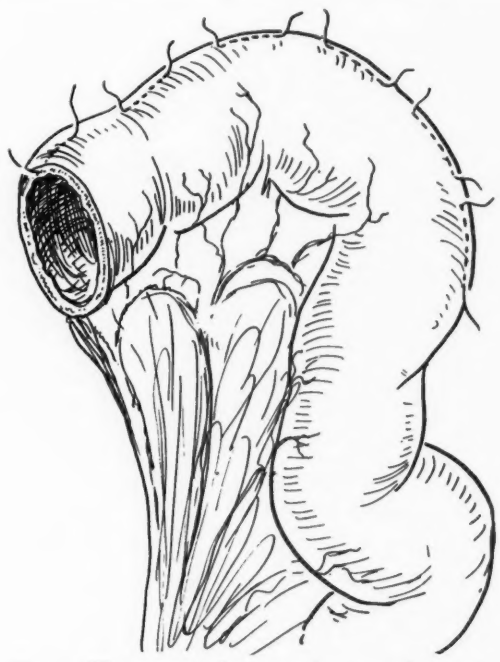


Fig. 3. Placement of sutures in muscular coat of ileum, without perforating mucous membrane.

to be the cause of wound disruptions, infections, and eviscerations, when the use of the suture material and the technic used are at fault.

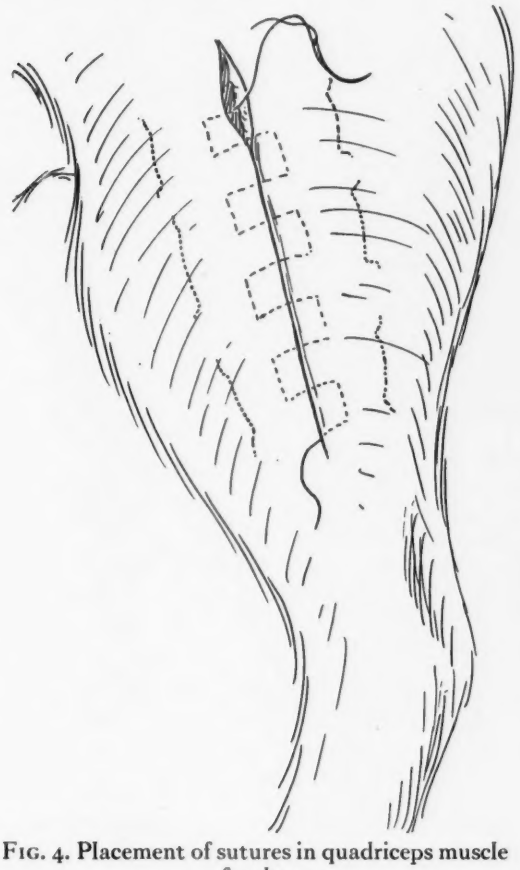


FIG. 4. Placement of sutures in quadriceps muscle of a dog.

The prerequisites for an ideal suture have been clearly and repeatedly set forth, but tissue reactivity should be the cardinal factor in choice of the ideal suture material. Halsted[15] believed, "the merits of sutures should be based entirely upon the reactivity in tissues, wound strength and ease with which they can be handled." By tissue reaction we mean the type and degree of response of various tissues to a foreign body. Nonirritating sutures will not induce the inflammatory changes which retard wound healing. Sutures causing the least reaction facilitate wound healing by reducing the inflammatory changes. Nevertheless, catgut, which causes the greatest reaction, is still the suture of choice, but the trend is changing to nonirritating sutures.

WOUND HEALING

Wound healing has been divided into two stages: (1) exudative or latent period, so-called lag-period; (2) reparative or fibroplastic period (Howes,[17] Arey[1]). The exudative or destructive stage includes chiefly lysis of cells and absorption of exudates. Autolysis and heterolysis is the chief function of the neutrophiles during the latent period, lasting from one to two days. The constructive changes are instituted by those cells which are commonly found in connective tissue, amoeboid cells, fixed macrophages, fibroblasts and mesenchymal cells. Catgut wounds have a longer latent or lag-period, lasting from four to eight days. There is a definite relationship between the microscopic picture of healing and the strength of the wounds, i.e., they are inversely proportional, the greater the

FIG. 5. Alloy steel 18-8 wire No. 36 in subcutaneous tissue three weeks. A, orifice through which the suture passed with the minimal amount of leucocytes and fibroblastic reaction in a surrounding zone. All microphotographs were taken of tissue from same dog and at same magnification.

reaction the weaker the wound. Wound disruptions following the use of catgut are not due to its absorbability (Howes[18]). It has been shown that disruptions usually occur before the suture has been absorbed (Botsfords[9]). Wound healing in the early stages is really a specialized manifestation of the general process of inflammation leading to provisional closing with fibrin which forms a substrata for the invading connective tissue cells (Arey[1]).

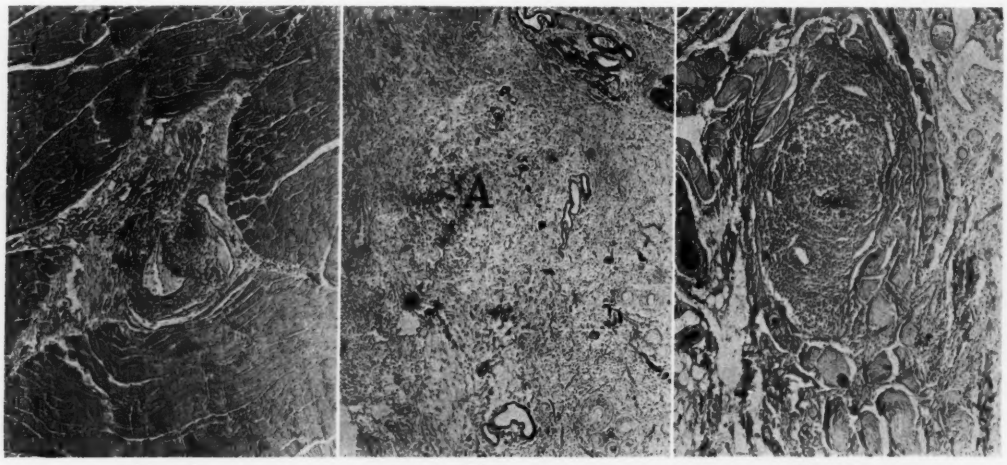


Fig. 6. Fig. 7. Fig. 8.

Fig. 6. Alloy stainless steel No. 36 in quadriceps muscle three weeks, showing mild cellular reaction occurring in intermuscular septum.

Fig. 7. Alloy steel No. 36 subcutaneous tissue three weeks. A, indicates suture site showing the least reaction of any sutures tested.

Fig. 8. Silk untreated three weeks showing the cellular infiltration surrounded by normal muscle.

In attempting to find an ideal suture material we have compared the tissue reactions of nylon, zytor, catgut, plastigut, glass thread, plain spool silk, treated silk annealed 18-8, stainless wire and cotton.

Twenty-five experiments were performed on ten dogs and three rabbits. The dogs were the same sex, age, and weight, free from any disease or skin infection. Intravenous anesthesia of pentobarbital sodium was used in proportion of 1 gr. per cc. per kilo of body weight for two-hour anesthesia, average dose being 5 to 10 cc. for the dogs.

The skin of the anterior abdominal wall was shaved, washed with tincture of green soap and ether, and finally painted with tincture of mercuric chloride. Implantation of the various sutures in the rectus muscle, quadriceps, unopened intestine, and stomach was carried out with routine aseptic technic, precautions being taken to reduce the possibility of infection. A vertical midline incision was made through the skin. The subcutaneous tissues were liberated from the anterior sheath of rectus and from the quadriceps muscle, well to the side of the incision. The six types of sutures used for comparison were of the finer sizes: catgut No. 000, nylon No. 000000 and No. 000, cotton No. 50, stainless steel No. 38, plastigut No. 0000, silk No. 1. These sutures were placed in the same tissue of each animal, with the same size curved needle, no ties or ligatures being used which might constrict or interfere with wound healing or cause irritation. This method reduces any of the external factors which may influence the results. A subcuticular stitch of suture material being tested was used to unite the wound edges. With the buried suture there was no tendency for the animals to pull, bite or lick the wound. No dressings were applied to the wounds of any animal. They were replaced in the usual cage and given the usual diets. On the sixth and twentieth postoperative days under nembutal anesthesia and with aseptic, the wounds were reopened and a wide ellipse of tissue was removed, including the test suture which had not been disturbed.

These were sent for microscopic sections. The incision was resutured and the animal used for other experiments. Before cutting the sections, sutures that would damage the microtome knife were removed. It became evident after several experiments that the reaction of tissues followed a definite curve over varying periods of time. The majority of reactions became pronounced from the fourth to the eighth day, then subsided by the end of the third week; hence, the reason for taking sections on the sixth and the twentieth days. (Fig. 1–4.)

Fig. 9. Fine waxed silk in subcutaneous tissue three weeks. A, indicates the strands of silk; B, surrounded by intense foreign body cellular reaction, showing infiltration of polymorphonuclear leucocytes and lymphocytes with beginning necrosis and suppuration.

Fig. 10. Cotton No. 40 in subcutaneous tissue three weeks. A, is suture site; B, shows the marked fibroblastic reaction with minimal leukocytic infiltration.

DISCUSSION

The quadriceps and rectus muscles seemed the ideal site for testing sutures. In these muscles possible infection from skin or intestinal flora was eliminated. The reactions occurring in the muscle sections were duplicated in other tissues of the body and in potentially infected wounds. The alloy stainless steel suture gave the least reaction of any tested. The reaction in the skin was practically nil. In the muscle there was absence of cellular, fibroblastic and edematous reaction about the suture which is so characteristic with catgut. In the intestine the degree of reaction was similar to silk. Stainless steel wire facilitates primary healing by causing a minimal amount of reaction, no capillarity and none of the usual inflammatory signs seen in the latent period. These findings have been confirmed by others experimenting with sutures. Bellas[7] states that "alloy wire makes the closest approach to the ideal suture." His objections are radioopacity and difficulty of surgical manipulation. Bothe, Beaton and Davenport,[8] from careful experiments with bone implants gave stainless steel, vitallium, and titanium the zero positions on the scale of bone reactions. Farris,[13] by his ingenious method

of testing sutures in the anterior chamber of the rabbit's eye, states that he could scarcely measure the reaction of stainless

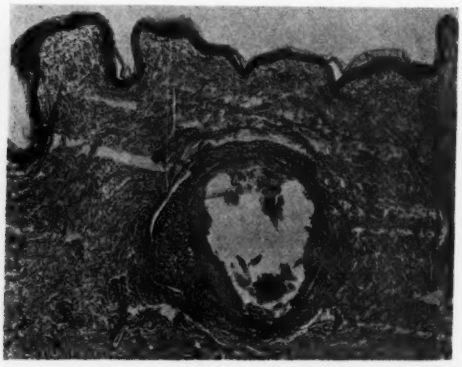


Fig. 11. Nylon 4-0, four weeks in subcutaneous tissue showing visible strands of nylon surrounded by leukocytes and lined by squamous epithelium.

steel wire. Babcock,[5] Jenkins,[22] T. Jones[23] and many others have shown clinically that stainless steel sutures have given a minimum of tissue reaction with a maximum of wound strength from the very first postoperative day. Microscopic studies confirm the results. (Fig. 5.)

Cotton and *plain spool silk* led to reactions of considerably less intensity than catgut, nylon or plastigut. (Figs. 9 and 10.) These sections were characterized by a small zone of leukocytic and round cell infiltration increasing up to the eighth day when fibroblastic replacement begins and reaches a maximum in the third to fourth week. Cotton has greater tensile strength than silk of equal size, especially after the sutures had been boiled several times. Boiling of cotton tends to increase the strength rather than weaken it. The addition of wax or other organic substance to increase the strength of sutures increases the reaction in the tissues. There was a greater area of inflammatory reaction especially of the highly cellular type. After two weeks, however, the reactions were quite similar. Organic substances and dyes used in the processing of sutures may increase the degree of reaction, which is inversely proportional to the wound strength during the first two weeks of healing. These organic and synthetic compounds prolong the exudative phase and retard the normal reparative phase of wound healing.

Nylon is a synthetic polymer, derived

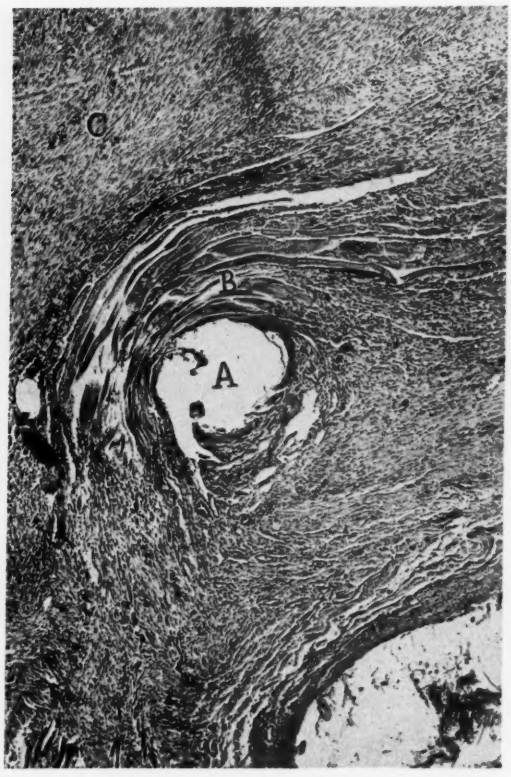


Fig. 12. Plastigut 000. in subcutaneous tissue after three weeks. A, opening through which the suture passed; B, showing the hyalinization about the suture; C, indicates the marked fibrotic reaction with surrounding dense layer of fibroblasts with only a few leucocytes next to suture opening.

from the chemical union of diamin and a dicorboxylic acid (Aries). (Fig. 11.) The organic composition of the suture explains the reason for its rather intense tissue reaction. The microscope revealed a very highly cellular type of reaction consisting of a wide zone of round cells and polymorphonuclear leukocytes, serum, giant cells during the first week and small areas of fibroblasts which gradually increase as the cellular reaction decreases. Finally, in three weeks fibroblasts predominated and the wound went into the reparative stage of healing. Epithelization of the squamous cell type was found to line the canal through which the sutures passed in the third week. Nylon seemed to favor or hasten epithelization. In many types of

wounds this characteristic is very desirable. Similarly with catgut and plastigut, the latent or lag-period was greatly increased

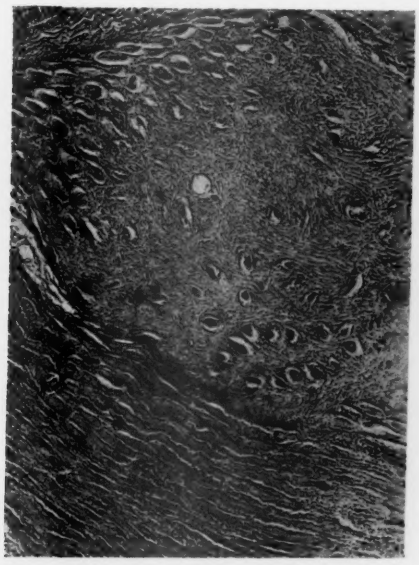


FIG. 13. Plastigut three weeks in quadriceps muscle showing extensive fibroblastic reaction surrounded by normal muscle fibers. All microphotographs taken with same magnification.

over the inorganic sutures, i.e., stainless steel and glass. Nylon, which has been treated with different vegetable dyes and marketed by various trade names, causes equally severe reaction in the clean as in the potentially infected wounds. In the skin a reaction measured 1 cm. in diameter and consisted of indurated friable inflammatory tissue which lasted for two weeks. There was no difference noted in reaction of the mono or multifilament nylon sutures. Further experiments are being carried out to determine if the untreated plain nylon gives less reaction than the treated varieties.

Plastigut is said to be composed of "incorporated synthetic materials especially selected; they are polymerized condensation products of aliphatic and aromatic alcohols and aldehydes." (Fig. 12.) The reaction was marked in comparison with other sutures tested, showing more fibroblastic reaction. The histologic picture with plastigut was unusual and quite characteristic. The opening through which the suture passed was surrounded by whirls of fibroblasts, many lying parallel to each other, long spindle type cells with only an occasional lymphocyte or polymorphonuclear

FIG. 14. Catgut No. 00 plain in subcutaneous tissue three weeks. A, shows channel through which suture passed; B, surrounding severe foreign body reaction of cellular type. Marked leukocytic infiltration, beginning necrosis and suppuration.

leukocyte. The reaction was very striking during the first week beginning as a cellular type in the brief destructive phase, rapidly changing to the fibroplasia which invaded the wound edges. This reaction continued until the third week when it gradually subsided. The extensive reaction, however, does not indicate strength in wound healing as demonstrated by Preston,[29] Haines, Aries and others. However, this type of reaction may have a definite place where fibroblast is desirable; for example, cellophane wrapped loosely about a dog's kidney produces a severe fibroblastic reaction which compressed the kidney to such an extent that hypertension was produced. We have been able to obliterate the femoral artery of a dog by loosely wrapping a roll of cellophane or plastigut 12 mm. wide

about the artery. Microscopic section shows the arterial wall to be three times the thickness and almost completely occluded by the fibroblastic reaction. (Fig. 13.)

Fig. 15. Silk untreated two weeks with visible strands of silk in muscularis coat of the stomach surrounded by zone of leukocytic infiltration with beginning fibroplasia in periphery.

Catgut, plain or chromic, produced the greatest reaction in comparison with stainless steel, silk, cotton, nylon and plastigut. (Fig. 14.) The anastomoses and wounds sutured with catgut were the weakest. The tissue through which it passed showed all signs of foreign body reaction from the fourth day until the catgut was absorbed. The reactions from chromic and plain catgut were highly cellular with a prolonged destructive phase characterized by giant cells, polymorphonuclear leukocytes and round cells; in many sections the central zone of reaction revealed loss of cell structure and beginning necrosis. The segments of catgut placed in muscle did not become infected but those in skin and intestine did show evidence of infection and sinus formation with spread of infection along the suture by capillarity. From these observations it would appear that patients whose wounds have been united with catgut are allowed out of bed when their wounds are the weakest, from the seventh to the fourteenth day, during the lag-period. In contrast, however, stainless steel which causes practically no reaction allows for early reparative phase. Clinically, this statement has been verified by those advocates of stainless steel. Babcock has had only one evisceration in the last 500 cases; this includes all types of abdominal surgery. Jones[23] has reduced his percentage of wound infection from 27 per cent in intestinal resection for carcinoma to 0.85 per cent by changing to all wire technic in the last 116 cases.

The *glass thread* was very difficult to handle, being very friable and easily broken at the eye of the needle. Experiments upon this type were abandoned for this reason, although placed in the skin of the abdominal wall it caused practically no reaction. The very fine fibers making up the thread frayed out and were difficult to remove from the wound.

The anastomosis performed between stomach, gallbladder, jejunum and ileum by the usual technic presented very interesting gross and microscopic findings. The experiment was directed toward a definite comparison of merits of the two most common sutures used for such anastomoses, namely, silk and catgut, with stainless steel. The anastomosis in which catgut or silk was used for seroserous suture (outer row) showed numerous dense vascular adhesions between liver, spleen and adjacent loops of intestine at the end of two weeks. Those anastomoses in which all wire technic was used or No. 36 wire alloy was used for outer row of seroserous interrupted suture were free from any gross evidence of adhesions or reaction. (Figs. 6 and 7.) As pointed out by Aries and others, continuous sutures in anastomoses of any type increases the danger, morbidity and mortality from the operation, by obstructing the lumen and increasing the bulk of strangled avascular tissue which becomes necrotic and sloughs into the lumen of the intestine. From our observations, however, accurate union of serous surfaces of the bowel by stainless steel alloy

is a desirable part of the anastomosis. The all steel suture technic gave minimal amount of reaction. The plain spool silk gave considerably less reaction than the waxed or treated type, again emphasizing the fact that organic substances as wax, oil, vaseline, etc., cause severe reactions. In one dog a piece of vaseline gauze was placed in the peritoneal cavity for ten days to see what reaction might occur when vaseline gauze is used for drains and packing. In ten days the gauze was encased in an inflammatory mass measuring 5 cm. in diameter, which had ulcerated through adherent ileum except for a very thin mucous surface. From our experiments the untreated sutures give the least reaction but are weaker in tensile strength. (Figs. 8 and 15.) The anastomoses in which catgut was used followed the usual type of dense inflammatory foreign protein reaction. These adhesions were noted when the anastomoses were examined at one, two and three week intervals.

SUMMARY

These animal experiments have shown that alloy steel metallic sutures give the minimal of reaction with maximum of tensile strength of wound. Cotton, silk (plain or waxed), plastigut, nylon and catgut show increasing degrees of reactions in the order mentioned. Plastigut shows excess fibrosis, while nylon stimulates epithelization, or proliferation of squamous cells in tissues through which the suture passed. Intestinal anastomoses using alloy steel wire as an interrupted seroserous suture gave practically no reaction and were free of adhesions at the end of two weeks.

REFERENCES

1. Arey. *Physiol. Rev.*, 16: 327, 1936.
2. Aries. *Surgery*, 9: 51, 1941.
3. Babcock. *Am. J. Obst. & Dis. Child.*, 74: 4, 1916.
4. Babcock. *Am. J. Surg.*, 27: 67–70, 1935.
5. Babcock. *J. A. M. A.*, 102: 756, 1934.
6. Bartlett. *Ann. Surg.*, July, 1903.
7. Bellas. *Arch. Surg.*, 41: 1414, 1940.
8. Bothe, Beaton and Davenport. *Surg., Gynec. & Obst.*, 71: 598, 1940.
9. Botsfords. *Surg., Gynec. & Obst.*, 72: 690, 1941.
10. Caller. *Ann. Surg.*, August, 1940.
11. Colp. *Ann. Surg.*, 99: 14, 1934.
12. Elkin, Daniel C. *Ann. Surg.*, 112: 280, 1940.
13. Farris. *Ann. Surg.*, 114: 1, 1941.
14. Glenn. *Surg., Gynec. & Obst.*, 65: 16, 1937.
15. Halsted. *J. A. M. A.*, 60: 1119, 1913.
16. Hollman. *Surg., Gynec. & Obst.*, 72: 1052, 1941.
17. Howes. *Surg., Gynec. & Obst.*, 57: 309, 1933.
18. Howes. *Surg., Gynec. & Obst.*, 73: 319, 1933.
19. Howes. *Surgery*, 7: 24, 1940.
20. Howes, Sooy and Harvey. *J. A. M. A.*, 92: 42, 1929.
21. Hunt, Allen H. *Brit. J. Surg.*, 28: 436–461, 1941.
22. Jenkins. *Surg., Gynec. & Obst.*, 64: 648, 1937.
23. Jones, T. *Surg., Gynec. & Obst.*, 72: 1056, 1941.
24. Kraissel. *Surg., Gynec. & Obst.*, 63: 561, 1936.
25. Levert, Henry S. *Am. J. M. Sc.*, 4: 17, 1829.
26. Lund. *J. A. M. A.*, 116: 663, 1941.
27. Meleney. *Ann. Surg.*, 98: 151, 1933.
28. Oschner. *Surgery*, 7: 485, 1940.
29. Preston. *Am. J. Surg.*, 49: 56, 1940.
30. Sims, J. Marion. Use of silver wire. Lecture at N. Y. Acad. of Med., Nov. 8, 1857.
31. Whipple. *Ann. Surg.*, 112: 48, 1940.
32. Whipple. *Ann. Surg.*, 108: 741, 1938.
33. Whipple. *Internat. Abstr. Surg.*, 69: 109, 1939.

Case Reports

INSTRUMENTAL INTESTINAL TRAUMA DURING LAPAROTOMY

SPONGE AND TISSUE FORCEPS INJURIES

HARRISON S. MARTLAND, M.D.
Chief Medical Examiner of Essex County
NEWARK, NEW JERSEY

IN the course of medicolegal postmortem examinations, the author has recently encountered two instances of severe trauma to the small intestine. These injuries were caused by repeated compression of the intestine by "loop sponge holding forceps" and "Babcock tissue forceps." In each instance these unfortunate complications occurred during the course of an exploratory laparotomy.

In a large autopsy experience, consisting of both medicolegal and permission autopsies, and extending over a period of many years, the author has never observed this type of intestinal injury.

However, since the findings may serve to re-emphasize the danger of undue and rough handling of tissues, it is believed that the following observations should be recorded. Personal inquiry amongst numerous surgeons has elicited the response that they had neither seen nor heard of similar injuries, and except for the possibility of tearing free a "red hot appendix" in a Babcock forceps, none had realized the damage which might result from the use of an instrument in a manner which apparently is very common amongst surgeons.

The operating surgeon, in both above noted instances, was very competent and well above average in his knowledge and application of operative technic. It is most interesting to note that one surgeon after his attention has been called to the intestinal injuries, related that occasionally after laparotomy (in which no work has been done on the gastrointestinal tract) the nurse's observations would record the presence of some blood in the stool. This soon disappeared and no particular attention apparently was paid to the possible significance of this observation.

CASE REPORTS

CASE 1. *Trauma to small intestine by a loop sponge holding forceps, during laparotomy for supposed intestinal obstruction: death on operating table from hemorrhage and shock.*

A female, colored, twenty-seven years old, was admitted to the hospital with a six-day history of nausea, vomiting and soreness in the epigastrium. Bilateral salpingectomy had been done three years ago. There was an indefinite history of recent treatment for syphilis.

The patient was observed for six days in the hospital during which her highest temperature was 101°F.; leucocytes, 6,000 per cu. mm. with 60 per cent polymorphonuclear leucocytes. A preoperative diagnosis of intestinal obstruction probably due to old adhesions was made. It is interesting that an intern had noted "impression not surgical" on the patient's chart. The patient complained of pruritus but though no dermatitis was noted, an arsphenamine reaction was suspected.

Operation was performed under open drop ether anesthesia. On opening the abdomen practically no gross pathological lesions were discovered. Volvulus was suspected since one segment of the intestine appeared to be somewhat discolored. The patient suddenly vomited and stopped breathing. Respiration was re-

stored and the appendix removed. The eviscerated intestine was then returned to the abdominal cavity by repeatedly grasping it with a uterine, straight, loop, sponge holding forceps. This instrument was 9¾ inches long, had round shanks, smooth jaws and a *box lock*. The abdomen was closed in layers in the usual manner. At the end of the operation the patient again ceased breathing and all resuscitation methods were of no avail.

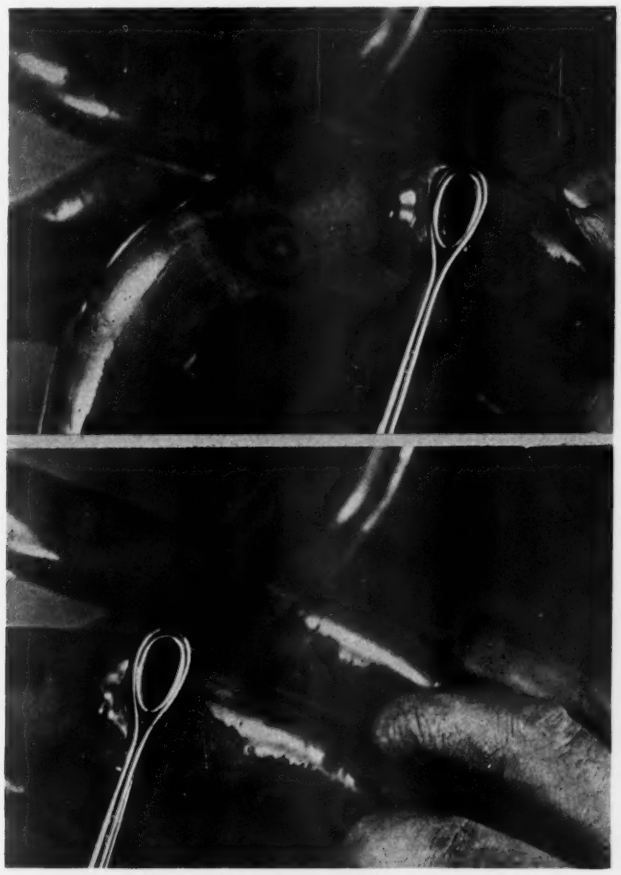


Fig. 1. Case 1. Several loops of small intestine after removal at autopsy. The characteristic "pattern marks" made by the loop of the sponge holding forceps may be noted.

Essential autopsy findings were as follows: An obese, colored woman, 180 pounds in weight, who had a recent lower midline laparotomy wound. A faint odor of ether came from the mouth. There was a small amount of light red fluid blood in the right side of the heart, and a faint odor of ether on section of the lungs.

The abdominal cavity contained no free blood; the small intestines presented a remarkable appearance; starting 6 inches below the duodenojejunal angle there were about fifty areas of light and dark red hemorrhage in the wall of the intestine extending over most of the intestine. Many of these occurred in pairs on each side of the intestine and showed typical "pattern marks" of the size and shape of the loop end of the sponge holder. This is positive proof that they were caused by the grasping forceps. Other marks were smaller and had no particular pattern.

The small intestine contained over 1,500 cc. of fluid blood in its lumen. The blood was found down to the ileocecal valve, with very little in the large intestine. Practically all the marks seen on the outside of the small intestine, extended through the entire gut wall and there was extensive submucosal and mucosal hemorrhages, often with fine linear laceration of the mucosa.

Both Fallopian tubes had been removed at a previous operation. The uterus was normal in size and appearance. Both ovaries were present and a recent corpus hemorrhagicum was observed in one. There was no gross evidence of syphilis and no significant pathological lesions in any of the other organs.

Comment. Since the lumen of the small intestine contained more than a quart and a half of blood, the cause of death was undoubtedly hemorrhage and shock. A complete autopsy, including microscopic and toxicological examinations, disclosed no other cause of death. (Figs. 1 and 2.)

FIG. 2. Case 1. The middle segment shows the small intestine from the serosal side. The segments on the right and left demonstrate the extension of the hemorrhages to the mucosa.

CASE II. *Traumatism to small intestine caused by a Babcock tissue forceps, during laparotomy for an "acute surgical abdomen;" death one day later from hemorrhagic pancreatitis.*

A male, white, twenty-nine years of age, was admitted to the hospital complaining of peri-umbilical, right rectus and left lumbar pain of four days' duration. The pain was sharp, constant, and aggravated by eating. Vomiting afforded little relief, and for the last forty hours the patient had been vomiting continuously. Constipation was present for four days; temperature 101°F., pulse 96, respirations 24 on admission; systolic blood pressure 130, diastolic 112. Urine showed a two-plus albumin and one-plus sugar; hemoglobin 107 per cent, erythrocytes 6,430,000 per cu. mm.; leucocytes 16,200 with 80 per cent polymorphonuclear leucocytes.

A preoperative diagnosis of an acute surgical condition of the abdomen was made, probably due to intestinal obstruction caused by old adhesions resulting from an operation for gangrenous appendicitis.

On opening the abdomen, very little gross pathological disturbance was discovered and after breaking up a few old adhesions the intestines were returned to the abdomen by repeatedly grasping it with a Babcock tissue forceps. This instrument had a smooth triangular end about three-eighths of an inch in width, and was fitted with a *box lock.*

The next day the patient was moribund. Temperature was 105°F., pulse 160 and respirations 50. He had had several convulsive seizures and death occurred twenty-four hours after operation.

Essential autopsy findings revealed the following: A well developed and nourished male body, about 180 pounds in weight. There was an old laparotomy scar in the right lower quadrant. The recent laparotomy wound in the left upper quadrant was covered by a surgical dressing.

There was extensive acute hemorrhagic pancreatitis involving the left half of the body and tail of pancreas with extensive necrosis, autolysis and hemorrhage. There was typical fat necrosis over the lesser abdominal sac, about the hilus of the spleen and along the mesenteric attachment of the descending colon, and a gaseous phlegmon running down over the left psoas muscle to the pelvic brim. Most of the general peritoneal cavity was normal and the lesion had apparently escaped the surgeon's detection.

The gallbladder and bile ducts were free of inflammation. The pancreatic ducts in the tail of the pancreas contained creamy pus.

Scattered over the small intestine were about forty hemorrhagic areas, similar to those seen in Case 1, except that many were smaller in size and showed typical "pattern marks" of the size and shape of the end of the Babcock tissue forceps. Many marks extended through the thickness of the intestinal wall and could be

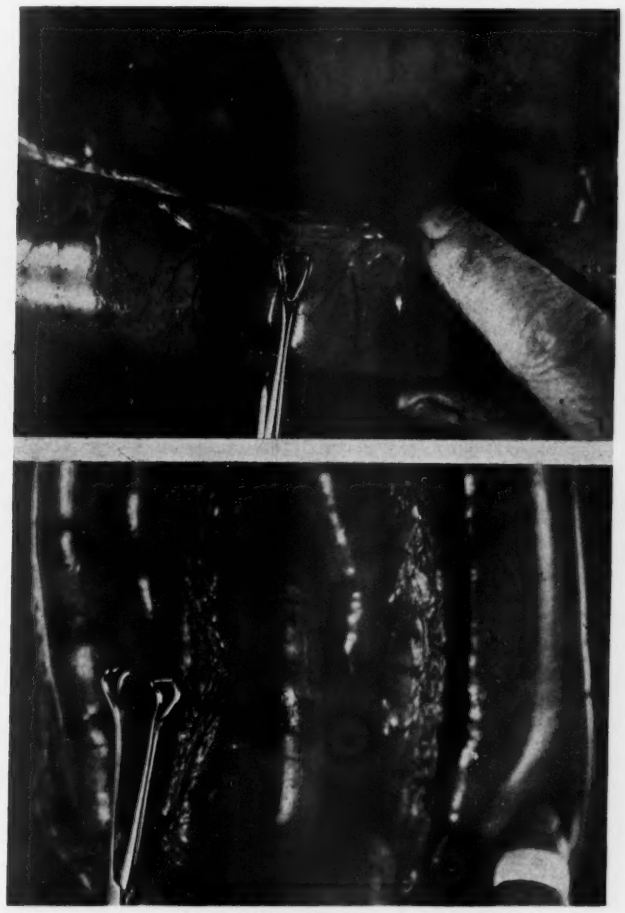


FIG. 3. Case II. Several loops of small intestine after removal at autopsy. The characteristic "pattern marks" assuming the size and shape of the grasping end of the Babcock tissue forceps may be noted.

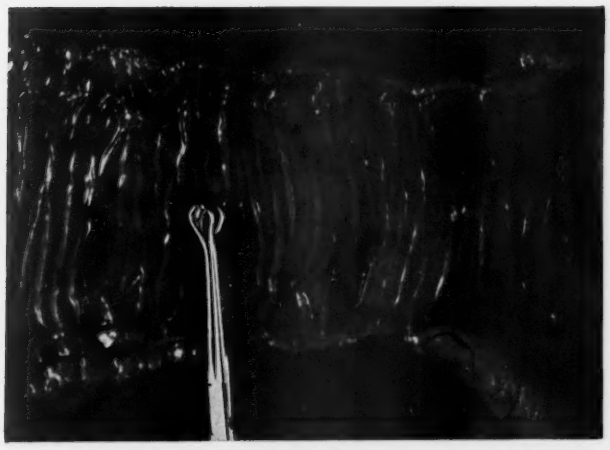


FIG. 4. Case II. Interior of small intestine with marks of injury extending to the mucosa.

seen from the mucosal side. There was very little laceration of the mucosa and no gross blood was found in the lumen of the intestine.

Comment. The cause of death in this case is of course the acute hemorrhagic pancreatitis. Since there was no evidence of blood in the lumen of the gut we must conclude that the intestinal injuries did not influence or aggravate the primary clinical condition. (Figs. 3 and 4.)

CONCLUSIONS

Two cases of severe injury to the small intestine are reported. The injuries are due to the rather common practice of returning eviscerated intestines during laparotomy by grasping them with various types of instruments.

In the first case a loop sponge holding uterine forceps was used. This has a box lock and is able to exert great pressure. The surgeon unwittingly may have "clicked" it down to the lock on several occasions. If the use of such an instrument is necessary, could it not be covered with rubber tubing of sufficient thickness to make it impossible to lock it? Or better still to have no ratchet or lock at all? This is a problem for the surgeon and instrument maker. Unfortunately, the intestinal hemorrhage caused by these forceps injuries caused death, since a careful autopsy ruled out any other cause.

In the second case, a Babcock tissue forceps was used. The injuries are similar to the first case but not so severe. This instrument also had a box lock. Since acute hemorrhagic pancreatitis is essentially a fatal disease, the injuries in this case did not apparently influence the outcome one way or another. In other circumstances, however, such injuries might seriously interfere with the postoperative convalescence.

It is quite possible that injuries of this type are much more common than one would suppose and since they frequently are not severe, the patient survives, and the cause of a stormy convalescence may be overlooked.

The importance of autopsies in fatalities after abdominal operations is emphasized.

WATER BLAST INJURY

REPORT OF TWO UNUSUAL CASES

COMDR. H. L. PUGH, M.C., U.S.N. AND LIEUT. R. M. JENSEN, M.C.-V(S) U.S.N.R.
PEARL HARBOR, T. H.

THE following cases illustrate several interesting surgical problems occurring in the course of blast injury to the abdomen. The first case demonstrates the ability of a sound physique to survive formidable surgical procedures and serious complications. The second case emphasizes the restorative powers of the human body when more conservative procedures are followed.

CASE REPORTS

R. L. S., a seaman second class, United States Navy, was admitted to the medical service of the Naval Hospital, Pearl Harbor, T. H. on June 9, 1942. His admitting diagnosis was compression injuries to abdomen and chest. He was critically ill and complained of pain in the right upper quadrant. His temperature was 100.8°F., pulse 124 and respirations were 28 a minute. Minimal dulness was noted over the left lung at the base, with suppression of breath sounds. The abdomen was markedly distended, tympanitic and no peristalsis was noted.

Continuous nasal suction was instituted; 2,000 cc. of oily gastric contents were aspirated in the first twelve hours. Human plasma, glucose in saline and sodium sulfadiazine were administered intravenously with improvement. His abdomen became less distended, he was passing flatus and had a good urinary output. However, his temperature and pulse remained elevated (temperature 102° to 103°F. and pulse 130 to 150). The sulfadiazine level the following day was 37.2 mg. per cent.

A roentgenogram of the chest showed some infiltration in the left basal area peripherally and throughout the lower third of the right lung. On June 15th, a flat plate of the abdomen revealed many dilated loops of small bowel in the upper part of the abdomen having a "step-ladder" or "closed loop" appearance.

After consultation with the chief of the surgical service he was transferred to the surgical ward on this date.

A Miller-Abbott tube was introduced and approximately 1,500 cc. of greenish-brown intestinal contents were aspirated. An ampoule of prostigmine 1-2000 was given every four hours. The following morning the abdomen was soft, temperature was 99°F., pulse 124 and respirations 24.

Following plasma and whole citrated blood in addition to intravenous fluids he continued to improve although there was roentgenological evidence of gas in the mid-small intestinal lumen.

On the morning of July 2, 1942, twenty-three-days after admission this patient was seized with abdominal cramps and vomited his breakfast. He obtained partial relief of his symptoms. Examination revealed his skin to be cool and moist, temperature was 101°F. and pulse 120. Except for some abdominal distention examination including a rectal was negative. The leukocyte count was 24,650 and differential count showed 23 band forms and 67 segmented cells.

After preliminary preparation consisting of continuous nasal suction, whole citrated blood and intravenous glucose solution, the patient was explored under spinal anesthesia. A left mid-rectus incision was made. A volvulus of the first eighteen inches of the jejunum was found. There was tremendous distention and complete gangrenous change extending to within two inches of the ligament of Treitz. This loop of jejunum contained what was apparently an old perforation and was densely adherent to the parietal peritoneum opposite the left kidney.

The patient was in marked shock at the time of operation and received plasma, coramine and intravenous glucose, but as the volvulus was reduced he appeared to rally appreciably. Due to the condition of the patient this stage of operative intervention was concluded as expeditiously as possible. A segment of gangrenous jejunum about eighteen inches long was resected. A catheter was introduced into the proximal stump of jejunum and a second catheter was introduced into the distal segment

of the small bowel, both being brought to the outside.

The day following the operation, secretion from the upper loop was dripped into the lower loop through the tube in conjunction with a mixture of pablum, egg, milk, gelatin, dextrose, orange juice and olive oil. Small repeated transfusions and intravenous plasma were used as supportive treatment.

On July 10, 1942, eight days following the resection a jejunojejunostomy was done under spinal anesthesia. By means of a Murphy button, the free ends of the jejunum were anastamosed. This was somewhat difficult due to the short proximal stump of jejunum, but was accomplished without incident.

On July 16, 1942, the edges of the wound separated exposing peritoneum and jejunum but with careful taping and vaseline gauze dressings the wound was allowed to granulate in from below.

The Murphy button was passed nine days after the jejunojejunostomy and the patient seemed well on the road to recovery. However, on the late afternoon of this day the patient suddenly developed respiratory difficulty and a slightly productive cough. He had no chest pain. Physical examination revealed temperature of 102°F., slight cyanosis (nails and cheeks), his pulse was 120 and numerous coarse râles could be heard on auscultation throughout both lung fields, but were more marked over the left base. Blood pressure was 120/60. A roentgenogram of the chest revealed cloudiness of the lung parenchyma of the left base. Leukocytes numbered 21,650. It was thought that he had a bronchopneumonia with associated acute pulmonary edema. He responded to adrenalin, aminophyllin and sulfathiazole. Oxygen was administered by tent. In five days his temperature returned to 100°F. and his pulse remained between 100 to 110. He was definitely improved.

Specific pneumococci were not isolated from the sputum. Blood culture was negative and the leukocyte count had dropped to 14,650.

The remainder of his course was uneventful. He was allowed up twenty-one days after his jejunojejunostomy.

Except for his abdominal wound which was gradually healing and for some loss of weight he appeared to be in good condition. He was returned to the mainland for further convalescence and for a probable repair of his abdominal wall at a later date.

The second case, W. V. A., age twenty-eight, a gunner's mate third class, United States Navy, was admitted to the Medical service of the U. S. Naval Hospital, Pearl Harbor, T. H., on June 9, 1942. His diagnosis was compression injury (blast) of the abdomen and chest.

This man was about eighty yards away from his ship wearing a life jacket and hanging on to a life raft, with his back to the blast. Forty-five minutes after the blast he noted abdominal cramps which increased in severity.

On admittance, physical examination re-revealed a well developed and well nourished adult male who appeared critically ill. Temperature was 101.2°F., pulse 100, respirations 24. The abdomen was distended and tympanitic. Rhonchi were noted over the base of the right lung on auscultation. Urinalysis revealed: albumin, one plus, 6 to 8 leukocytes and 5 to 10 erythrocytes per high dry field. Hemoglobin was 15 Gm. per 100 cc. of blood, erythrocytes 4,950,000 and leucocytes 12,400 in each cubic millimeter of blood. Total neutrophiles in a differential smear were 76 per cent.

A roentgenogram of the chest revealed no definite pulmonary changes and the heart was not enlarged.

Roentgenoscopy of the abdomen showed no air under either diaphragm. However, the left diaphragm was relatively limited in motion and there was evidence of some pleural reaction in the left costophrenic angle. The right psoas muscle and right kidney were not visualized. Increased density was noted in the right side of the abdomen above the crest of the ilium. Numerous small bubbles of gas were noted behind the liver shadow and in the region of the right kidney. Some gaseous distention of the loops of the small intestine was noted but the findings were not characteristic of an obstruction.

Blood chemistry studies including non-protein nitrogen, chlorides and total protein were within normal limits.

The patient was placed under constant nasal suction. Glucose, saline and human plasma were administered. Sodium sulfadiazine was given intravenously and the following day the blood sulfadiazine level was 39.9 mg. per cent.

One week after admission the patient complained of pain high in the abdomen and some rigidity in the right upper quadrant was noted. The following day he developed a cough, rapid,

shallow respiration, and râles could be heard over both lower lung areas. A roentgenogram of the chest revealed areas of increased density in the lower lobes of both lungs.

Twelve days after admission, tenderness was present and a mass was palpable in the right upper abdominal quadrant. Leukocytes numbered 22,250 and a differential count revealed 2 juveniles, 35 bands and 42 segmented neutrophiles, totaling 79 per cent.

After consultation with the surgical service (Dr. Pugh) the patient was transferred to the surgical department where the following day an exploratory laporotomy was performed through a right rectus incision, under local anesthesia. An abscess in the right anterior inferior hepatic space was drained. A large gangrenous slough, which appeared to be most of the greater omentum was removed along with a large amount of exudate and tissue detritus.

Following this he improved markedly. Copious drainage continued from the wound and three days after exploration fecal material was noted in the drainage.

About a week following the establishment of this fecal fistula a mass of tissue simulating the end of a gangrenous segment of gut presented in the wound. Upon slight traction it carried away and was delivered in its entirety. Examination revealed this to be a segment of large bowel measuring 8 cm. in length. The wound was cleansed and irrigated daily and small amounts of whole blood and plasma were given as supportive treatment.

On July 12, 1942, a barium enema was given. This revealed a fistula extending to the anterior abdominal wall from the superior portion of the hepatic flexure. The remainder of the colon showed no abnormalities.

On July 29th, the wound was almost completely healed. Free drainage had ceased and the patient was up and around.

He made an uneventful recovery and except for slight upper abdominal distress and nausea following meals had no complaints.

A gastrointestinal series on September 2, 1942, revealed some adhesions in the region of the second portion of the duodenum. No other abnormalities were noted in the gastrointestinal tract although the hepatic flexure was not subjected to further examination by means of a barium enema at this time.

Pathological examination of the removed tissue revealed necrotic omentum and a segment of bowel showing evidence of old hemorrhage.

He was returned to a mainland hospital for further convalescence.

Aside from the interest which attaches to these cases by reason of their having sustained their original injury as a result of water blast, they are considered worthy of special report because of the unusual and interesting character of the pathological entities presented by each.

In the first case, that of R. L. S., several very notable and relatively rare features were presented:

1. This man sustained a perforation of his jejunum some two feet below the ligament of Treitz. The mortality rate from perforation of the jejunum from any cause is very high. More remarkable than his survival of this accident is the fact that this perforation sealed itself off spontaneously and never would have been discovered but for the subsequent developments which necessitated emergent operative intervention.

2. The patient developed a volvulus of his jejunum. This is rare. In the proceedings of the Staff Meetings of Mayo Clinic, Volume 17, No. 28, McKechnie and Priestly reported thirty-four cases in which thirty-seven operations were performed at the Mayo Clinic for volvulus of the small bowel. The jejunum *per se* was involved in only two of the thirty-four cases. In fact, volvulus of the entire small bowel is more common than volvulus of the jejunum alone.

The mortality from complete intestinal obstruction in the upper part of the alimentary canal is 100 per cent if not promptly relieved. When gangrenous bowel is involved in the obstruction whether from mesenteric thrombosis or strangulation, the prognosis becomes grave indeed.

In this case the proximal jejunum was gangrenous for a distance of 40 cm.

The mechanical factor which had made this volvulus possible was the adhesion of

the bowel, at the site of the jejunual perforation, to the parietal peritoneum opposite the upper pole of the left kidney.

Owing to the desperate condition of the patient at the time of the resection of the gangrenous bowel, attempt at restoration of the continuity of the intestinal tract was regarded as highly inadvisable. That there was a perceptible improvement in the patient's condition almost immediately upon clamping off the mesentery of this gangrenous bowel, is worthy of note.

A high intestinal fistula leads to rapid depletion and prostration of the patient. The importance of maintaining adequate fluid balance, food, electrolytes, digestive juices, caloric and vitamin intake, was recognized and successfully managed in this case.

With no more than one and one-half inches of the proximal jejunum projecting below Treitz ligament (and this in an unhealthy condition), the matter of accomplishing the re-establishment of the continuity of the bowel was mechanically tedious and difficult.

The Murphy button is an ingenious device introduced by the late John B. Murphy, a great and resourceful surgeon of one-half century ago. This button was used in establishing anastamosis in this case and we doubt that it could have been successfully effected by any other means aside from mobilizing the duodenum and bringing it over the transverse colon, after the method described by Lahey, which is in itself a formidable surgical undertaking.

That the Murphy button is indeed a potential life saver we think should not be lost sight of.

3. For this patient's ability in his weakened state to withstand and recover from an intercurrent pneumonia some credit undoubtedly belongs to the effectiveness of the sulfonamide drugs (sulfathiazole) and much credit is due to the prompt and efficient management of the medical service of this hospital.

Lastly, in the final analysis, the importance of three valuable allies were reflected in the survival of this man: The stamina of youth, he was seventeen years of age; his indomitable courage; and his excellent physical condition at the time of his original accident.

The latter of these two cases was of unusual interest because it illustrates in particular two things. First, How so little in the way of surgery may mean so much. Here, an abscess was drained under local anesthesia and within a short time the patient's condition was converted from one of distress to one of calm and relative comfort; second, the assistance of nature when given a chance.

It seems remarkable enough that the continuity of the bowel may be re-established so satisfactorily by means of such a procedure as the Mickulicz operation. However, in this patient, after the entire greater omentum sloughed off, and the 8 cm. segment of the hepatic flexure or transverse colon had sloughed out, the bowel went on to re-establish its continuity and to resume normal function spontaneously.

Here, as with the pneumonia in the first case, the use of sulfadrugs may have prevented a lethal exodus from generalized peritonitis and again, as was pointed out in the first case, youth, stamina, and an attitude of the highest morale and vigorous health at the time of the original accident were on his side.

TYPHOID OSTEOMYELITIS*

CASE REPORT

GRAHAM A. KERNWEIN, M.D. AND RICHARD B. CAPPS, M.D.
CHICAGO, ILLINOIS

OSTEOMYELITIS was recognized as a sequel of typhoid fever as early as 1835 by Maisonneuve.[1] It was not until 1881, however, that Eberth[2] discovered the Bacillus typhosum, and 1888 that Ebermaier[3] isolated the Bacillus typhosum in pure culture from two cases of osteomyelitis. The relation of the bone manifestations to the initial phase of the disease was thereby definitely established.

Clinical and experimental proof that the typhoid bacilli exist and linger longest in the bones gradually has accumulated. Chantemesse and Widal[4] innoculated rabbits and recovered the bacilli only from the bone marrow. This localization in the bone marrow has been confirmed repeatedly in rabbits[5,6] and guinea pigs.[7] Quincke and Stühlen[8] in nine postmortem examinations of individuals who had died of typhoid fever found the bacilli in the bones in each. Gerbasi,[9] in thirteen cases of typhoid fever, obtained positive results from cultures taken from the tibial bone marrow. Since Gerbasi's report, approximately two hundred cases[10–13] have been subjected to sternal puncture, all with positive results. Cultures of the stool, urine and blood in many failed to grow bacilli.

The bacilli remain viable for years after the initial attack, as attested by the cases cited in Table 1.

TABLE 1

Author	Time between Initial Attack and Recovery of Bacilli from Bone Marrow—in Years
Gore[14]	11
Tubby and Hicks[15]	13
Porter[16]	20
Fogh[17]	23
Garr[18]	27

Improved sanitation and the inception of prophylactic measures to combat typhoid fever have decreased markedly the frequency with which the disease is encountered. As the incidence of clinical osteomyelitis was 0.82 per cent in 18,840 cases of typhoid fever reviewed by Murphy,[19] and as Winslow[20] in a review of all the medical literature up to 1923 found

FIG. 1. Roentgenogram of forearm showing region of decreased density in ulna.

* From the Division of Surgery and the Department of Medicine, Northwestern University Medical School, Chicago, Illinois.

only 101 bacteriologically proved cases of typhoid osteomyelitis, it is apparent that the disease is uncommon.

sulfamethylthiazole. A fourth patient responded neither to sulfamethylthiazole nor sulfanilamide. In vitro studies[22,23] reveal

FIG. 2.

FIG. 3.

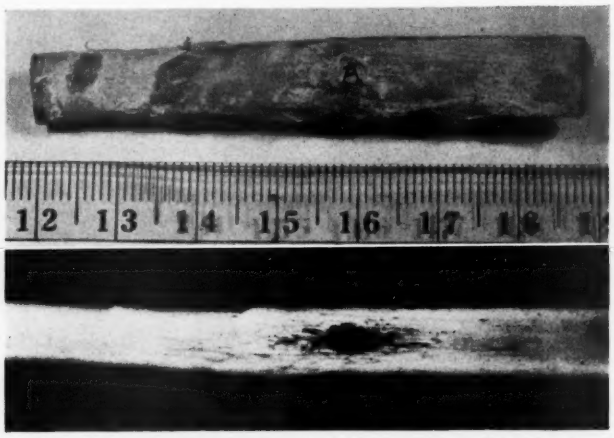


FIG. 2. Gross specimen. Cortical bone removed from ulna; periosteum greatly thickened in region A.
FIG. 3. Roentgenogram of specimen showing region of decreased density intact.

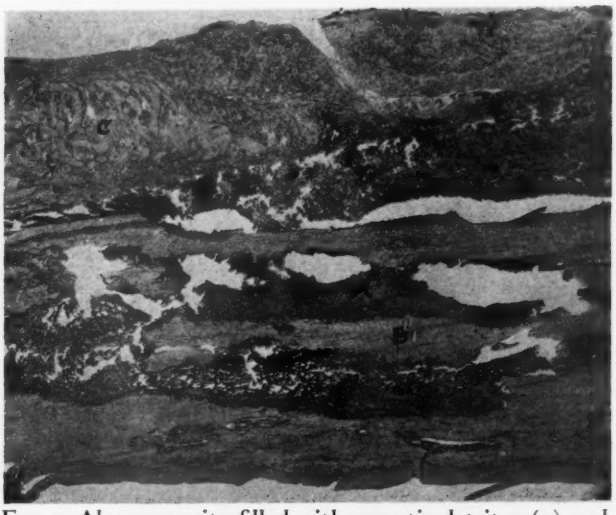


FIG. 4. Abscess cavity filled with necrotic detritus (A) and containing a sequestrum (B). Periosteal new bone (C) is present except in the region immediately overlying the abscess cavity. Here there is a mature type of granulation tissue containing clusters of closely packed mononuclear cells and foci of eosinophilic polymorphonuclear leucocytes. Most of the periosteal new bone has been destroyed leaving only a few remnants with irregular borders. × 24.5.

In the treatment of typhoid fever and its sequels, the value of chemotherapy with the sulfonamide drugs has not been established. Weilbaecher, Moss, Taylor and Dupuy[21] report good results in two cases and indefinite results in a third instance of typhoid fever treated with

that the sulfonamide drugs have a bacteriostatic action and that sulfathiazole is more active than sulfanilamide or sulfapyridine against the colon-typhoid-dysentery group. In this report apparent benefit resulted with chemotherapy locally in the bowel and at the operative site.

CASE REPORT

R. B., a white female, twenty-four years of age, contracted typhoid fever in March, 1941. An unfavorable course and prognosis were markedly improved following treatment with sulfaguanidine (70 Gm.) in divided doses beginning April 12, and continuing until April 22. The first negative stool was obtained May 20th and was followed by three others. Late in June, the patient noted a dull pain in her left forearm. The pain increased and by the second week was so severe as to interfere with her sleep. The pain was much worse at night.

Examination revealed a well nourished, cheerful, white female who did not appear acutely ill. The skin overlying the left ulna in a region 3 cm. in diameter, its center 10 cm. distal to the tip of the olecranon, was slightly reddened, edematous and boggy. The underlying bone was extremely tender to pressure. The remainder of the skeleton was negative.

The laboratory reported that the Wassermann was negative; red blood cells, 4,700,000; hemoglobin 14.5 Gm.; white blood cells, 15,300; differential count: lymphocytes, 23; polymorphonuclear neutrophils, 72; eosinophils, 3; monocytes, 2. In the urine there was no albumin, and no sugar; microscopically a few epithelial cells were found. Cultures for typhoid bacilli showed no growth on July 10, 1941. Stool cultures for typhoid bacilli showed no growth on July 10, 1941 and July 12, 1941.

The bone marrow removed at operation and cultured for typhoid bacilli was positive. The patient's temperature never rose above 99.2°F.

Roentgenological examination of the left forearm revealed an irregularly oval region of decreased density in the crest of the ulna. There was no endosteal reaction about the lesion but along the cortex, overlying the area of decreased density, the shadow of a minimal amount of periosteal new bone was seen. (Fig. 1.)

At operation the soft tissues were unusually adherent to the ulna in the proximal third. The periosteum beneath the edematous skin was markedly thickened and roughened. The periosteum was incised away from the thickened portion and a piece of cortex and attached periosteum were removed with the aid of an Albee bone saw. The lesion of osteomyelitis was not opened into; no pus was seen. Regional marrow was removed and sent to the laboratory for bacteriological study. Cultures of this marrow grew only typhoid bacilli. The marrow cavity was packed with three

FIG. 5. Dead bone (A) surrounding the abscess cavity. The center of the cavity contains necrotic detritus (B). Peripherally there is a ground work of mature granulation tissue (C) containing many large mononuclear cells. The surfaces of the trabeculas are deeply serrated and in many of these pockets there are large cells (D) some with more than one nucleus. × 120.

Gm. of sulfathiazole crystals and the soft tissues were closed tightly without drainage. The postoperative course was uneventful. The wound healed by primary intention.

Grossly the specimen consisted of dense cortical bone, 7.0 by 1.9 by 0.6 cm., and attached periosteum. The periosteum was markedly thickened, roughened and closely adherent. The medullary surface was slighly concave and smooth. (Fig. 2.) Roentgenological examination of the specimen revealed an area of decreased density in the center of the specimen. (Fig. 3.)

Microscopic sections were cut parallel with the long axis of the specimen. A layer of periosteal new bone was present, except immediately overlying the region of bone destruction. There the periosteal bone had been destroyed. Only isolated spicules remained in a ground work of dense fibrous

tissue. In some places, numerous large mononuclear cells were associated with regions of lacunar absorption where they lay close to the bony trabeculae. Elsewhere foci of eosinophilic polymorphonuclear leucocytes were present. In the central portion of the destructive lesion of the cortex the marrow spaces were filled with necrotic detritus and the bony trabeculae were devoid of bone cells. Peripheral to this in some places the marrow spaces were filled with a polymorphonuclear leucocyte type of granulation tissue. In others, the spaces were filled with a mature type of granulation tissue in which large mononuclear cells predominated. Where they lay opposed to the bony trabeculae, these cells were associated with regions of lacunar absorption. More peripherally, the enlarged Haversian canal systems were filled with an adult type of granulation tissue, a finding also present in pyogenic osteomyelitis and known as rarefying osteitis. (Figs. 4 and 5.)

Keen stated "the tendency to chronicity, to persistent sinuses and especially to recurrences are among the most marked characteristics of bone disorders following typhoid." This, coupled with the fact that an individual is a carrier so long as the bone lesion continues to drain typhoid bacilli, early resulted in a departure from the accepted methods of treatment of pyogenic osteomyelitis. While treatment of pyogenic osteomyelitis consisted of drainage and packing the wound open, the recommended treatment of typhoid osteomyelitis was to excise the lesion surgically and close the wound without drainage.[24] Although this method met with some success[25,26,27] Murphy (1916),[28] following an exhaustive review of the subject, concluded that "the results of treatment of typhoid osteomyelitis are generally unsatisfactory."

In this report, the wound, created by surgical excision of the bone lesion, was packed with sulfathiazole crystals, then closed without drainage. The complete success of this method of treatment coupled with the excellent clinical response of the fever to sulfaguanidine, suggests that local chemotherapy with sulfonamide drugs is beneficial in typhoid fever and typhoid osteomyelitis.

REFERENCES

1. Maisonneuve. These d'agregation, Paris, 1835.
2. Eberth, Carl Joseph. Die Organismen in den Organen bei Typhus abdominalis. *Arch. f. path. Anat.*, 81: 58–114, 1880.
3. Ebermaier, A. Ueber Kochenerkrankungen bei Typhus. *Deutsche Arch. f. klin. Med.*, 44: 140–148, 1888–1889.
4. Chantemesse, A. and Widal, F. Recherches sur le bacilli typhique et l'etiologie de la fievre typhoide. *Arch. de physiol. norm. et path., Par.*, 9: 217–300, 1887.
5. Dmochowski, Z. and Janowski, Med. W. Ueber die Eiterung erregende Wirkung des Typhusbacillus. *Ziegler Beitr. z. path. Anat.*, 17: 221, 1891.
6. Gay, F. P. Typhoid Fever. New York, 1918. Macmillan Co.
7. Ludke, H. Ueber den latenten Mikrobismus der Typhusbazillen. *München med. Wchnschr.*, 56: 57, 1909.
8. Quincke, H. and Stühlen, A. Zur Pathologie des Abdominaltyphus. *Berl. klin. Wchnschr.*, 15: 351–354, 1894.
9. Gerbasi, M. Ricerche sulla patogenesi e sulla diagnosi della febbre tifoide nei bambini. *Pediatria*, 32: 113, 1925.
10. Debré, R., Lamy, M., Sée, G. and Mallarme, J. L'exploration de la moelle osseuse (lamyelographie et la medullo culture). *Presse méd.*, 44: 1853, 1936.
11. Storti, E. and Filippi, C. Étude morphologique et bacteriologique de la moelle osseuse dans la fièvre typhoide. *Sang*, 11: 440, 1937.
12. Basserga, A. and Barbagallo, G. Die Sternalpunktion als bacteriologische Hilfsmethode. *Med. Klin.*, 34: 178, 1938.
13. Sacks, M. S. and Hatchel, F. W. A note on the bacteriologic culture of bone marrow in typhoid fever. *J. Lab. & Clin. Med.*, 26: 1024, 1941.
14. Gore, W. R. Case of caries of frontal bone and intracranial abscess due to bacillus typhosus eleven years after attack of typhoid fever. *Proc. Roy. Soc. Med., Surg. Sect.*, 1–4, 5: 1911–1912.
15. Tubby, A. H. and Hicks, J. A. B. A case of suppurative posttyphoid osteitis 13 years after an attack of enteric fever. *Lancet*, 1: 304, 1913.
16. Porter. Quoted by A. Wilensky. Osteomyelitis, its pathogenesis, symptomathology and treatment. P. 263. New York, 1934. Macmillan Co.
17. Fogh, R. Ein Fall von posttyphoser suppurativer Knochenentzundung mit ausserardentlich longwierigem Verlaufe. *Deutsche med. Wchnschr.*, 34: 1305, 1908.
18. Garr, C. C. Typhoid osteitis; report of two cases. *South. M. J.*, 20: 296–301, 1927.
19. Murphy, J. B. Bone and joint disease in relation to typhoid fever. *Surg., Gynec. & Obst.*, 23: 119–143, 1916.

20. WINSLOW, N. Typhoidal osteomyelitis. *Ann. Surg.*, 77: 319, 1923.
21. WEILBAECHER, J. O., JR., MOSS, E. S., TAYLOR, H. M. and DUPUY, H. Treatment of typhoid fever by thiazole derivatives of sulfanilamide; preliminary report of four cases. *South. M. J.*, 33: 645–648, 1940.
22. LIBBY, R. L. and JOYNER, A. L. Action of sulfathiazole on colon-typhoid-dysenteriae group of organisma. *J. Infect. Dis.*, 67: 67–69, 1940.
23. RAMMELKAMP, C. H. and JEWELL, M. L. Comparative in vitro study of various sulfanilamide derivatives on typhoid-dysentery organisms. *Proc. Soc. Exper. Biol. & Med.*, 45: 169–174, 1940.
24. KEEN, W. W. Surgical complications and sequels of typhoid fever; based upon a review of 1700 cases. Philadelphia, 1898. W. B. Saunders.
25. UNGER, E. Beitrag zu den posttyphosen Knocheneiterungen. *Deutsche med. Wchnschr.*, 27: 522, 1901.
26. DUPRAZ, A. L. Deux cas de suppurations (thyroidite et ostéomyélite) consécutives à la fièvre typhoide et causées par le bacilli d'Eberth. *Arch. de méd. expér. et d'anat. path.*, 4: 76–84, 1892.
27. LILIENTHAL, H. Typhoid osteomyelitis. *Internat. J. Surg.*, 20: 71, 1907.
28. MURPHY, J. B. Bone and joint disease in relation to typhoid fever. *Surg., Gynec. & Obst.*, 23: 119–143, 1916.

GANGRENE is rarely encountered in the genital tract except in extreme degrees of puerperal infection, in malignant neoplasms, or as the result of torsion or thrombosis of the pedicle of benign neoplasms or of the broad ligament.

ACTINOMYCOSIS OF THE LIVER AND LUNGS

ROLAND T. SMITH, M.D.
DES MOINES, IOWA

THIS is a case of actinomycotic abscesses of the liver and lungs found at autopsy after a five and one-half month stormy convalescent period following surgical closure of a ruptured gastric ulcer.

After the closure of the ruptured ulcer, the patient left the hospital in five weeks against our advice. He returned in one month with pain and tenderness in the right upper quadrant which was controlled so well under ulcer management that he left the hospital in one week. He returned three weeks later with a stitch abscess. The abscess was drained and the patient seemed to make some improvement for one week, but from then on, he gradually lost ground and in three weeks signs and symptoms of a liver abscess developed.

After several transfusions and after general supportive measures were given in order to prepare the patient for an operation, a laparotomy was performed and the sinus tract was explored. The sinus tract extended from the old operative closure of the stomach to the anterior surface of the liver over the omentum, which had been sutured at the previous operation to the stomach at the site of the ulcer. It is interesting to note that the site of the operative closure of the stomach allowed no escape of gastric contents. The tract continued over the anterior and superior surface of the liver to the dome and from there it had burrowed along the thoracic wall, finally coming to the surface through the rectus muscle and skin just below the costal margin. No abscess could be found. The wound was closed with drainage, and the wound continued to drain thick, greenish-yellow exudate for seven weeks till the patient died. Smears from the pus, liver contents, and sputum, and the blood culture were negative for actinomycosis or any other pathogen. The diagnosis of actinomycosis of the lungs and liver was made from the sections of the tissue obtained at autopsy.

There are two cases reported in the literature which are very similar to this case.[2,7] In both cases there was *x*-ray evidence of thickened pleura in the bases. In both cases a liver abscess or subdiaphragmatic abscess was suspected and a laparotomy was performed at which time liver abscesses were found. The exudate of these abscesses did not contain the organism of actinomycosis. In one case there was a draining sinus from the lung, and smears from this material also were negative for actinomycosis as were the smears made from the sputum. In both cases at autopsy there were multiple abscesses in the lungs, and sections of this tissue showed actinomycosis.

Another case of actinomycosis of the liver followed a suppurative appendicitis. The appendix of this case contained the ray fungus.[6] During the course of the illness, the anterior abdominal wall was later attacked and many fistulas developed.

In another case in which the lungs were primarily infected, there were later metastases to the pelvis. The most remarkable thing about this case was the spontaneous cure. Iodides, radium, and *x*-ray were not used.[10]

MORTALITY RATES

The mortality rate in actinomycosis of the liver is 80 to 100 per cent, and most writers fear the 100 per cent is more correct.[1–10] In actinomycosis of the lungs alone the mortality rate is a little less, being about 70 per cent.

SUMMARY ON TREATMENT

From the mortality figures it seems hopeless to discuss treatment, but occasionally

there are cures reported which appear to be due to the treatment. One such case of pulmonary actinomycosis was said to be cured by three capsules of thymol daily, each containing 10 gr. (.65 Gm.) for seventeen days.[3] Another author prefers to use radium, 6,900 milligram hours, in divided doses supplemented with potassium iodide and *x*-ray.[3] The *x*-ray is probably best given with 135 peak kilovolts with 4 to 6 mm. of aluminum for filtration with two-thirds to three-fourths of an erythema dose.[5] Saturated solution of potassium iodide is given in increasing doses till 600 minims (37 cc.) is given three times a day, or until tolerance is reached. Tincture of iodine may be given instead, 6 to 10 minims (37 to 61 cc.) in milk three times a day, or "collosol iodide," .2 of 1 per cent intravenously. Abscesses must be drained freely wherever they are found.

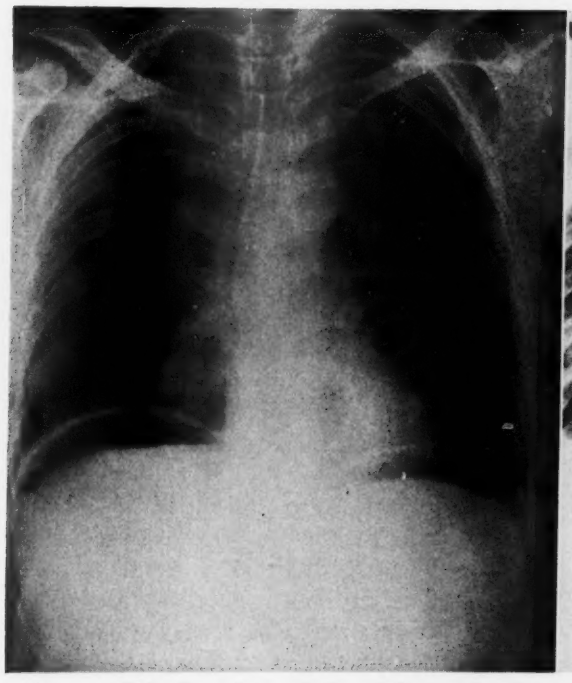


Fig. 1. This flat plate of the abdomen in the upright position was taken in the hour of the patient's admission to the hospital. It shows air under the diaphragm, a condition which in these circumstances is pathognomonic of a ruptured gastrointestinal tract.

Fig. 2. This *x*-ray was taken one month before the patient's death and shows a rather high diaphragm on the right side. There is some blunting of the right costal phrenic angle and slight infiltration of the right base. The film, however, is somewhat misleading in that, at autopsy, the left lung was involved as much as the right.

CASE REPORTS

This patient, J. A. No. 113040, a painter, was first seen at the hospital on June 2, 1941, with symptoms of a ruptured peptic ulcer. There was a sudden severe pain in the epigastrium which caused the patient great anxiety. He was gasping for air and perspiring.

The past history is significant in that in 1911, the patient went to the Mayo Clinic for an examination which revealed that he did not have a peptic ulcer, although he had been having epigastric distress relieved by food or soda for one year. These symptoms continued until 1927 after which they did not return. He had had the usual childhood diseases. There was nothing of significance in the family history, cardiorespiratory, gastrointestinal or genitourinary systems.

Physical examination revealed the patient to be a well nourished, white male of fifty years, acutely ill. In the abdomen there was marked generalized tenderness and rigidity, somewhat more pronounced on the right side.

By rectal examination there was slight tenderness high in the pelvis. In the urine there were two to four white blood cells per high power field and zero to one red blood cell per high field. In the blood there were 3,700,000 red blood cells and 6,000 white blood cells, 89 per cent polymorphonuclears and 11 per cent lymphocytes. An *x*-ray of the diaphragm in the upright position revealed large quantities of air beneath both domes.

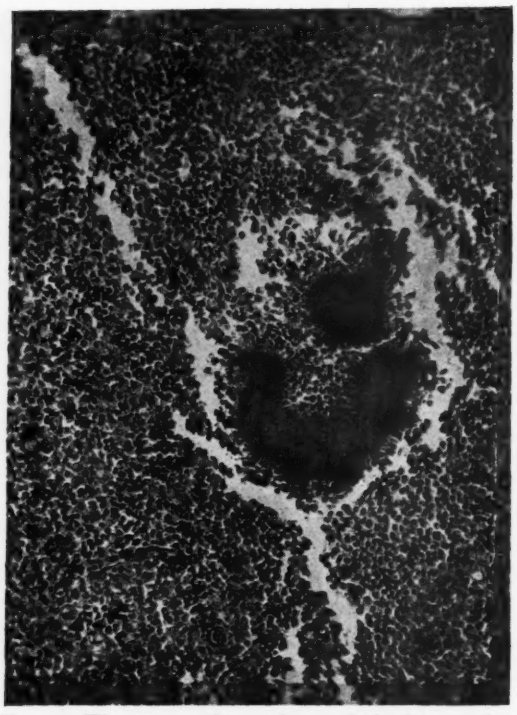


Fig. 3. The report from the pathologist on the tissue from which the above microphotograph was made was that the abscesses contained granules of the size and general morphology of the sulphur granules of actinomycosis. The margins of the granules are brush-like in appearance, but do not show deep clubbing, a fact which is consistent with tissue sections.

An exploratory laparotomy was then done by Dr. D. W. Coughlin, at which time a perforation was found just above the pylorus. The perforation was closed with four interrupted catgut sutures and the omentum attached over this. A stab wound was made in the hypogastrium and a drain placed through this from the pelvis. Another drain was placed near the pylorus through the wound in the epigastrium, which was then closed in layers.

The patient had the expected, somewhat stormy, post-operative course with the temperature reaching 101°F. occasionally, and on one day, 103°F. The wound became infected and drained a considerable amount of purulosanguineous exudate and was still draining some when the patient left the hospital on the thirty-eighth postoperative day against our advice. He was given a ten-day Sippy diet, amphojel, cevitamic acid, Brewer's yeast, and told to stay in bed.

The patient returned in exactly one month complaining of a constant pain in the epigastrium which radiated to the right side and was accompanied with considerable eructation. The only significant findings on examination were the healed right rectus scar, tenderness and spasm in the epigastrium, severe pain on deep pressure, and the lack of palpable organs and masses. The laboratory at that time showed 3,700,000 red blood cells and 13,200 white blood cells, 74 per cent polymorphonuclears and 16 per cent lymphocytes. The urine had very occasional white blood cells. Fluoroscopic examination of the chest was negative. Oral barium demonstrated a normal esophagus, stomach filled well and was smooth and pliable. The duodenal bulb was poorly visualized and appeared irregular throughout the examination. Both sections of the diaphragm moved satisfactorily. Films showed the irregularity of the bulb. The patient's distress soon ceased on bed rest and ulcer management, and he was discharged in one week on the same treatment.

Three weeks later the patient returned complaining of pain and swelling at the upper part of his old abdominal incision. The significant finding on examination was a large subcutaneous abscess under the upper part of the wound which was promptly incised and drained, whereupon, three ounces of thick, green pus was obtained. The laboratory report at that time was 3,700,000 red blood cells, 70 per cent hemoglobin, 15,000 white blood cells with 77 per cent polymorphonuclears and 23 per cent lymphocytes. A smear from the pus showed few pus cells but no bacteria. On the nutrient broth culture there was no growth.

There was a profuse greenish-yellow discharge from the wound for five days after which the discharge greatly diminished but never ceased. After the drainage from the wound became less profuse, the temperature began to rise slowly each day with a spike of fever in the late afternoons. After one week of this a chest *x*-ray revealed slight elevation of the right diaphragm with no evidence of

accumulation of free air or gas below the diaphragm.

The temperature curve continued to spike each afternoon to 102°F. and after four days a fluoroscopic examination showed the right diaphragm not elevated but definitely limited in movement and the right liver shadow much larger than normal. There was no evidence of free air or fluid level under either diaphragm.

The wound was probed and a sinus was found leading up under the costal margin for three inches. A subdiaphragmatic abscess was suspected so the patient was given transfusions and general supportive measures in preparation for an exploratory operation later. In two weeks a chest *x*-ray showed blunting of the right costal phrenic angle and slight haziness in the right base.

An exploratory laparotomy by Dr. R. A. Burnside was then done through the right upper quadrant exposing the liver and stomach. A sinus tract composed of chronic granulation tissue was found extending from the anterior abdominal wound to the dome of the diaphragm. From there the tract ran over the superior and anterior surface of the liver and then over omental adhesions to the site of the old operative closure of the stomach which appeared to be well sealed and would allow no escape of gastric contents. No abscess or any gross pus was found. The liver appeared normal. One large rubber drain, and a long thin strip of gauze was placed over the liver, and the abdomen was closed in layers. For a number of days the wound continued to drain a profuse amount of greenish-yellow exudate and later it became only moderate in amount.

The patient gradually failed, spiking a temperature of 103 to 104°F. every day. Three weeks postoperatively, a chest *x*-ray revealed a high diaphragm on the right side and a slight infiltration of the right base. Three weeks later an attempt was made to aspirate an abscess in the liver but this was unsuccessful. A blood culture was negative, the sedimentation rate was 100 mm. per hour; the Wassermann was negative; agglutination for typhoid and undulant fever was negative. The sputum was negative for any bacteria. The prothrombin time was 44 seconds (the control was 35 seconds). The icteric index was 6 (normal, 4 to 8). The Van den Bergh was direct, but delayed one minute. The white blood cell count during the last month of his illness ranged from 12,000 to 23,000, slipping to 7,400 the last week. The red blood cell count continued to drop slowly to 2,400,000 in spite of multiple transfusions. He died fifty-one days after the exploratory operation.

At autopsy, these were the significant findings: In the skin of the abdomen there was a denuded area about 8 cm. in diameter from a suppurating fistula just below the costal margin on the right side. The peritoneal cavity contained 300 cc. of straw-colored fluid, and between the right diaphragm and the dome of the liver, there were numerous adhesions. The pleural cavities each contained 200 cc. of straw-colored fluid. The heart was smaller than average. The coronaries were quite atherosclerotic. Both lungs contained numerous small abscesses measuring 1 to 3 cm. in diameter, containing green pus. The specimen was enlarged and quite firm. In the gastrointestinal tract there was a perforating, but not perforated, gastric ulcer with adhesions into the right lobe of the liver. The liver was filled with multiple abscesses varying from 2 to 5 to 6 cm. in diameter, containing a thick greenish, foul, purulent material. These abscesses appeared more or less in clusters in the liver and seemed to be loculations of one continuous system. This arrangement was not so definite in the lungs. A few areas of the liver were very soft and necrotic.

SUMMARY

1. A case of actinomycotic abscesses of the lungs and liver is presented.

2. When the patient entered the hospital he had signs and symptoms of a ruptured peptic ulcer. The ruptured ulcer was found at surgery and closed successfully.

3. Signs and symptoms of a liver abscess developed two months after the surgical closure.

4. A chronic sinus tract was found at an exploratory laparotomy. This sinus tract extended from the anterior abdominal wall to the dome of the liver and from there to the old operative closure of the stomach, which, however, allowed no escape of gastric contents.

5. The wound drained a thick, greenish-yellow exudate for seven weeks till the patient died.

6. Smears of the pus, liver contents and sputum, and a blood culture were negative for actinomycosis or any other pathogen.

7. The diagnosis of actinomycosis of the lungs and liver was made from the sections of the tissue obtained at autopsy.

8. Treatment is unsatisfactory. Iodides, thymol, *x*-ray, and radium have been used.

REFERENCES

1. Aribaud, G. Hepatic localizations of actinomycosis. *Internat. Clin.*, 3: 50, 1931.
2. Cottle, G. F. and Satterlee, R. C. Actinomycosis of liver and lungs. *U. S. Nav. M. Bull.*, 19: 341–343, 1923.
3. Etter, L. E. and Schumacher, F. L. Pulmonary actinomycosis: recovery after thymol therapy. *J. A. M. A.*, 113: 1023–1024, 1939.
4. Good, Louis P. Actinomycosis of the thorax. *Arch. Surg.*, 21: 786–800, 1930.
5. Good, Louis P. Thoracic actinomycosis, with report of case of primary type. *Texas State J. Med.*, 30: 245–250, 1934.
6. Greenwell, A. W. Actinomycosis of liver following suppurative appendicitis. *Mil. Surgeon*, 62: 185–197, 1928.
7. Hutchinson, R. W. and Zundell, J. L. Actinomycosis of lungs and liver; report of case. *U. S. Nav. M. Bull.*, 38: 325–329, 1940.
8. Lemon, W. S. Pulmonary actinomycosis. *Minnesota Med.*, 9: 211–213, 1926.
9. Schneider, L. V. and Finucane, D. L. Pulmonary actinomycosis complicated by pneumothorax treatment. *Dis. of Chest*, 7: 229–235, 1941.
10. Trevithick, E. A case of actinomycosis: primary abscess of left lung exhibiting spontaneous cure; metastatic manifestation in the pelvis declaring itself after a years' latency with abscess formation and slow spontaneous cure. *Lancet*, 2: 158, 1906.

Fibro-adenomata of the cervix differ from those arising in the endometrium only in the fact that they are rough on the surface, are covered with the cervical type of mucosa, and do not usually exhibit the changes of the menstrual cycle.

MECKEL'S DIVERTICULUM AS A CAUSE OF INTESTINAL OBSTRUCTION*

REPORT OF A CASE OF VOLVULUS

MILTON ROTHMAN, M.D.
Resident Surgeon, Harlem Hospital;
Pathologist, Harlem Hospital

AND

DOMINICK F. ZETENA, M.D.
Associate Surgeon, Harlem Hospital; Assistant Surgeon, St. Vincent's Hospital

NEW YORK, NEW YORK

INTESTINAL obstruction not infrequently follows Meckel's diverticulum. Such a case recently occurred at Harlem Hospital. The formation of Meckel's diverticulum as a remnant of the omphalovitelline duct through which nourishment passes from the yolk stalk to the embryo has been amply discussed and reiteration is unnecessary.

In 1809, Johann Friedrich Meckel[1] described the condition which bears his name. The early reports were for the most part concerned with intestinal obstruction. Meckel observed that this congenital anomaly in the omphalovitelline vessels could easily act as a band producing an obstruction. This probably was the mechanism in the first case of intestinal obstruction due to this cause, that of Van Doeveren, which was described by Sandifort[2] in 1793.

The incidence of Meckel's diverticulum has been variously estimated from 0.14 to 3 per cent. The condition occurs more commonly in males than in females. The diverticulum usually occurs from 3 to 100 cm. above the ileocecal valve. The site apparently depends upon the amount of growth in that portion of the intestine proximal to the insertion of the omphalovitelline duct. Therefore, in infants in whom complete growth has not yet taken place it may be found closer to the ileocecal valve than in adults. It may be a thin fibrous band, cystic or bulbous, with a narrow or broad base. Diverticuli arise opposite the mesentery of the bowel, but may be lateral or even intramesenteric. Histologically, it must be classified as a true diverticulum for its walls are identical with that of the intestine. It is estimated that heterotopic tissue such as gastric and duodenal mucosa, or pancreatic tissue, is present in 15 per cent of the cases.

The vast majority of diverticula lie free in the peritoneal cavity and usually give no symptoms. Although a blind pouch, it seldom entraps foreign bodies. Nearly always, the symptoms arise from one of the various complications to which the diverticulum is subject. Halstead[3] states that 6 per cent of 991 cases of intestinal obstruction were due to Meckel's diverticulum. Although these figures are undoubtedly high, nevertheless one notes that Meckel's diverticulum is not an uncommon cause of intestinal obstruction. Harkin's[4] report shows that Meckel's diverticulum is a factor in about 2 per cent of all cases of intussusception. Miller and Wallace[5] found sixty-three cases of intussusception in 201 cases of Meckel's diverticulum. In this group there were twenty-six other cases of intestinal obstruction.

Meckel's diverticulum may produce intestinal obstruction in one of the following ways: (1) Meckel's diverticulum may form the contents of a hernial sac, (2) intrinsic mechanism causing intussusception, and (3) extrinsic mechanism (a) free diverticulum, (b) adherent diverticulum.

HERNIAL SAC

The diverticulum may form partial or complete contents of a hernial sac. Mathew[6] presented a case in which a

* From the Surgical Service of Dr. Leon Ginzburg, Harlem Hospital, New York City.

diverticulum was found in a femoral hernia. In another case the diverticulum was brought down into an inguinal hernia by the descent of the testis. Biodorax[7] noted a sciatic hernia which contained an adherent diverticulum. Other authors noted similar findings in umbilical hernias. On the whole, these are uncommon. Wellington,[8] in 1913, collected seven such cases in 1,326 cases of Meckel's diverticulum.

INTRINSIC MECHANISM—INTUSSUSCEPTION

Almost always the diverticulum is situated at the apex of the intussusceptum. Probably the starting point is the expulsion of a fecal mass or a concretion from its lumen into the intestines. The diverticulum becomes inverted and acts as a polyp to initiate an intussusception. The conditions essential in the invagination of the diverticulum are two-fold, a free tip and a broad base. The chief subject of argument has been whether the diverticulum invaginates primarily or secondarily. At present, the bulk of the evidence favors the view that the inversion is primary. In Harkin's series of cases, intussusception occurred mostly in the group above two years of age. It is the opinion of Mathews that Meckel's diverticulum is not a cause of intussusception in young children.

EXTRINSIC MECHANISM

(*A*) *Free Diverticulum.* There are several ways in which a free diverticulum may produce an obstruction. A knot may be tied around a loop of gut. This requires a good size diverticulum of unusual length and great range of mobility. Dragging and kinking of a loop of intestine may be produced by a distended diverticulum. It is obvious that acute flexion occurs more frequently when the distal end of the diverticulum is attached. Similarly, twisting of the bowel on its long axis at the point of origin of the diverticulum is more frequently found in the adherent diverticulum. Chronic inflammation of a diverticulum may involve the base resulting in a cicatricial narrowing of the gut at the origin of the diverticulum. In the operative treatment of a diverticulum, one may cause an obstruction by inversion with purse-string suture.

(*B*) *Adherent Diverticulum.* A tip of a diverticulum may attach itself to adjacent viscera or the abdominal wall, and cause a partial or complete intestinal obstruction. This is the result of an inflammatory process. On the other hand, the diverticulum may have remained attached to the umbilicus embryologically, and the obstruction may be secondary to this mode of adherence. These bands may constrict the bowel or the circulation of a loop of gut that has tunneled its way underneath the band. As mentioned above, dragging, of the bowel, or twisting of the diverticulum would be more common in this group. McKenzie[9] and Symmonds[10] each reported cases in which a loop of gut passed underneath an adherent diverticulum and became twisted on itself, producing a volvulus. Lower[11] presented a report of a volvulus of a loop of ileum around an acutely inflamed diverticulum which was adherent to the cecum. The volvulus was relieved and the diverticulum removed. A case is now presented in which a Meckel's diverticulum became adherent to a loop of ileum, and the whole mass was twisted 720 degrees upon itself, producing a volvulus.

CASE REPORT

G. K., a colored male, aged twenty-nine years, was admitted to Harlem Hospital on August 19, 1941, with the history of having had a sudden attack of crampy umbilical pain two days previously. Vomiting of thin greenish fluid accompanied the pain. The symptoms became progressively worse. There was no passage of flatus for ten hours. The history did not reveal melena, distention, previous operations, enema or a previous similar attack.

Physical examination revealed an acutely ill colored man complaining of constant pain in the lower abdominal quadrants. Skin turgor was poor and he appeared dehydrated. The upper part of the abdomen was moderately distended. The lower quadrants were rigid and presented rebound tenderness. There were no masses. On rectal examination a tender mass was felt in the cul de sac.

The temperature was 101°F., the respiration was 20 and the pulse was 110 beats per minute. The hemogram showed the following: erythrocytes 3,200,000, hemoglobin 70 per cent, leukocytes 16,900. The differential count showed polymorphonuclear leukocytes 69 per cent, transitional cells 12 per cent, monocytes 3 per cent and lymphocytes 16 per cent. The urine was negative for sugar and albumin. The specific gravity was 1,018 and there was two plus acetone.

An operation was performed three hours after admission. Under 12 mg. pontocaine spinal anesthesia, a right rectus spliting incision was made. The peritoneal cavity contained about 2,500 cc. of sanguineous, fecal smelling fluid. A round purplish mass measuring 10 by 10 by 12.5 cm. was found bound down in the right pelvis. It was necessary to untwist the mass 720 degrees counterclockwise before it could be delivered. At this point, a distended Meckel's diverticulum was noted to be adherent to a loop of ileum. This point of adherence was evidently the pivotal point for the volvulus. The entire loop of ileum, measuring about 4 feet (120 cm.) starting 6 inches (15 cm.) from the ileocaecal valve, was gangrenous and the mesentery was thrombosed. A resection of the gangrenous bowel was performed. Because of the proximity to the cecum, after the resection was completed, an ileotransverse colostomy in a side-to-side manner was performed. Twelve Gm. of sulfanilamide was placed into the abdominal cavity. The abdomen was closed in layers without drainage.

The surgical pathologic report follows: The specimen consisted of 4 feet of small intestine. The entire specimen was completely gangrenous except for 6 inches at either end. Eight inches from the distal end, was a blind finger-like projection measuring 3 by 2 by 1.0 inches. The tip was bulbous and a denuded area was noted at the tip where it had been adherent to a loop of ileum. No areas of perforation were present. The mesentery was hemorrhagic and thrombotic for a distance of 3 inches from the bowel wall. The bowel and diverticulum were filled with thick sanguineous fluid. No fecoliths or purulent material were present in the diverticulum.

Following the operation the temperature ranged between 101° and 102°F. for the first three days. On the fifth day, the temperature was normal, daily bowel movements were started on the fourth day. Sutures were removed on the seventh day and the patient was out of bed on the sixteenth day and went home on the nineteenth day. Immediate postoperative therapy consisted of infusion of normal saline and 5 per cent glucose, two transfusions of 500 cc. citrated whole blood, duodenal tube and Wangensteen drainage. Sodium sulfathiazole 4 Gm. was given intravenously upon return to the ward and then 1 Gm. every four hours for five days thereafter. The patient received 500 mg. of vitamin C and 100 mg. of vitamin B_1 daily throughout his stay in the hospital.

The symptoms are those of any intestinal obstruction: vomiting, colicky pain, obstipation or constipation, and distention. It is apparent that a diagnosis of intestinal obstruction can be made, but a definite diagnosis of obstruction secondary to a Meckel's diverticulum can only be made with exceeding difficulty. However, such a condition can be suspected. In those cases in which the cause of the obstruction is not apparent, the possibility of the presence of a Meckel's diverticulum should be suspected. A previous history of melena may be helpful. In cases in which the intussusception is made in older children and adults, a diverticulum should be thought of as a possible cause. Roentgenograms show obstruction during the acute stage.

The treatment of the hernial sac and bands due to Meckel's diverticulum is essentially the same. The obstruction should be relieved and the diverticulum removed. However, one must be aware of the possibility that a stricture might be caused by inverting with a purse-string suture. After removal of the diverticulum the intestine should be closed transverse to the long axis of the bowel. The handling of a diverticulum resulting in an intussusception depends on the operative findings. It may be relieved simply by disinvagination. If the invagination cannot be relieved, a resection must be performed in a one or two-stage procedure.

SUMMARY

The subject of intestinal obstruction following Meckel's diverticulum is generally

discussed. The details of a case of volvulus secondary to Meckel's diverticulum with operation and recovery are also presented.

REFERENCES

1. Meckel, J. F. Ueber die Divertikel am Darmkanal. *Arch. f. d. Physiol.*, 9: 421–453, 1809.
2. Sandifort. Museum Anatomicum. Series III, 1: 121, 1793.
3. Halstead, A. E. Intestinal obstruction from Meckel's diverticulum. *Ann. Surg.*, 35: 471–494, 1902.
4. Harkins, H. N. Intussusception due to invaginated Meckel's diverticulum. *Ann. Surg.*, 98: 1070–1095, 1933.
5. Miller, R. H. and Wallace, R. H. Meckel's diverticulum in acute abdominal emergencies. *Ann. Surg.*, 98: 713, 1933.
6. Mathew, F. Meckel's diverticulum. A report of 12 cases. *Arch. Surg.*, 10: 720–729, 1925.
7. Biodorax, John W. Sciatic hernia: report of a case of hernia of Meckel's diverticulum through the greater sciatic foramen. *J. A. M. A.*, 82: 440–442, 1924.
8. Wellington, J. R. Meckel's diverticulum with report of four cases. *Surg., Gynec. & Obst.*, 16: 74–78, 1913.
9. McKenzie. (Quoted by Halstead.) Transactions of the London Pathological Society 1889–1890.
10. Symmonds. *Brit. M. J.*, December 4, 1897. (Quoted by Halstead.)
11. Lower, W. E. Intussusception in adults due to the invagination of a Meckel's diverticulum. *Ann. Surg.*, 82: 436, 1925.

Glandular cancer of the vulva may arise from any of the glandular structures of the skin or mucosa, or from definite glands such as the vulvovaginal gland.

The brief excerpts in this issue have been taken from "Essentials of Gynecology" by Willard R. Cooke (J. B. Lippincott Company).

GLIOBLASTOMA MULTIFORME

REPORT OF THREE CASES

HENRY WARD WILLIAMS, M.D. AND WILLIAM P. E. BERWALD, M.D.
Senior Neurosurgeon, Highland Hospital — Junior Neurosurgeon, Highland Hospital
ROCHESTER, NEW YORK

GLIOMAS constitute almost 50 per cent of all intracranial neoplasms, and of these, the glioblastoma or spongioblastoma multiforme is the commonest. This tumor is the most malignant of all cerebral neoplasms with the possible exception of the medulloblastoma. The average duration of life from the time of discovery is approximately seven months. They tend to occur in middle-aged and elderly people and are characterized by a rapid progression of those signs and symptoms associated with an intracranial space-occupying lesion. Many of these tumors are unfortunately situated either subcortically, or in areas where their removal would be followed by a hemiplegia, aphasia, or visual-field defect. On the other hand, some will be situated in relatively "silent" areas of the brain, such as the right frontal or postfrontal regions in right-handed individuals, and it is these that are most amenable to surgical attack.

In the past two and one-half years we have effected apparently complete extirpation of three grade IV spongioblastoma multiforme tumors in three male patients, all in the fifth decade of life. One patient has now lived two and one-half years following surgery, another one year, and the third patient eight months. All three are in good general health at the present time, and two of the three have been economically rehabilitated. We present below case reports on these patients, all of whom are right-handed, and had right postfrontal gliomas:

CASE REPORTS

CASE 1. D. R., a male, age forty-six, was admitted to St. Mary's Hospital January 5, 1940, with the diagnosis of "Jacksonian epilepsy." One year before admission he was seized by a "fit" involving the left face, arm and leg, not accompanied by unconsciousness. Similar episodes had occurred subsequently at irregular intervals. Some spells were preceded by olfactory hallucinations. There had been some blurring of vision and rather steady occipital headache.

Examination of the central nervous system was objectively negative. The optic disc margins appeared distinct. Our impression was right temporal lobe tumor. An encephalogram was performed. The spinal fluid initial pressure was 420 mm. water; 142 cc. of cerebrospinal fluid were recovered. Radiographs showed a convexity of the outer border of the right lateral ventricle.

Craniotomy was performed under avertin, gas oxygen and novocaine. A right temporoparietal five-hole osteoplastic flap was made. The dura was tense and on reflection a gelatinous mass, one and three-quarters inches in diameter, in the temporal lobe and bordering the Sylvian fissure, came into view. The mass was removed with the cutting loop and a subtemporal decompression was performed. Rapid frozen section of biopsy diagnosed malignant glioma. The operative time was three hours and twenty-five minutes. The patient received 350 cc. citrated blood immediately following operation.

Postoperatively there was no aphasia or weakness. The fourth postoperative day the patient had a convulsion limited to the left side. The patient was discharged on the thirteenth postoperative day improved.

Permanent section of the biopsy was diagnosed a very cellular malignant glioma.

Since operation, he has had from three to five Jacksonian seizures per month. The spells are limited to the left side, are of short duration and are not accompanied by unconsciousness. It is now two and one-half years since his operation. His general health is good, his decompression is soft and pulsates, and his optic disc

margins are distinct. He has not, however, become economically rehabilitated.

Case II. M. McD., a male, age forty-eight, was admitted to Highland Hospital July 10, 1941, with the diagnosis of "convulsions." Eight years before admission he had a Jacksonian convulsion lasting an hour, and involving only the left arm. Another similar spell occurred six years later and was followed by weakness in the left arm which persisted. He had repetitive Jacksonian convulsions for six hours prior to admission. Severe headaches had been present for several months.

Examination of the central nervous system revealed mental lethargy. The external ocular movements were defective in upward and right lateral gaze. The tongue deviated to the left. Strength in the left arm was minus two, in the left leg and foot, minus one. The deep reflexes in the left arm were plus two. Babinski's sign was positive bilaterally. Ankle clonus was plus two on the left. The optic disc margins were distinct. Our impression was right postfrontal tumor. An encephalogram was performed. The spinal fluid initial pressure was 650 mm. water; 100 cc. of cerebrospinal fluid were recovered. The radiographs were unsatisfactory.

Craniotomy was performed under avertin, ether vapor and novocaine. A right frontotemporal five-hole osteoplastic flap was made. The dura was tense, and on being reflected disclosed a yellowish, gelatinous mass over the anterior aspect of the decompression. A tumor the size of a horse chestnut was removed with the cutting loop, and a subtemporal decompression was done. The dura was left open. Rapid frozen section of the biopsy diagnosed glioma. The patient received 500 cc. of citrated blood during the operation. The operative time was three hours and five minutes.

Postoperatively the patient presented a left hemiplegia; however, he moved his left leg the third postoperative day and his left arm the fifth postoperative day. He developed a Staphylococcus aureus wound infection which was treated successfully by irrigation of 1-5000 neutral acriflavine and the oral administration of sulfathiozole. He was discharged on the twentieth postoperative day, improved.

Permanent section of the biopsy was diagnosed spongioblastoma multiforme.

The patient was referred to a radiologist for post-operative *x*-ray treatment. It is now one year since his operation. His general health is good, he has had no headaches or Jacksonian seizures. The strength in both arms and hands is equal. His decompression is soft and pulsating and his optic disc margins are distinct. He has become economically rehabilitated.

Case III. H. G., a male, age forty-three, was admitted to Highland Hospital November 1, 1941, with the diagnosis of "hypertension." One month prior to admission, the patient complained of involuntary blinking of the eyelids, headaches and fatigue. His wife noticed that he was difficult to arouse in the morning and was very slow in getting dressed. For a week or so prior to admission, the patient had failed to keep important appointments.

Examination of the central nervous system revealed slight drooping of the left corner of the mouth. There was blinking and nystagmoid movements of the eyes. There was questionable weakness of the left arm and hand. The left patellar reflex was plus two. The left upper abdominal reflex was minus four. The left middle and lower abdominal reflexes were minus two. There was slight blurring of the nasal margin of the right optic disc. The patient presented some dysarthria and Witzelsucht. Our impression was right postfrontal tumor. An encephalogram was performed. The spinal fluid initial pressure was 600 mm. water; 121 cc. of cerebrospinal fluid were recovered. The radiographs revealed displacement of the ventricular system to the left with flattening of the upper surface of the right lateral ventricle and dilatation of the left lateral ventricle.

Craniotomy was performed under local anesthesia only. A right frontotemporal five-hole osteoplastic flap was made. The dura was very tense and did not pulsate. A large subtemporal decompression was done after which the dura was then reflected revealing a large gelatinous tumor two inches in diameter and well demarcated from the surrounding normal gray matter. The flap had to be enlarged anteriorly to obtain full exposure. The tumor and 1 cm. of surrounding brain tissue was removed with the cutting loop almost down to the wall of the ventricle. A large old blood clot was present within the tumor mass. A drain was left in the tumor cavity and the dura closed around it. Rapid frozen section of the biopsy diagnosed glioma. The patient received 500 cc. of citrated blood during the operation. The operating time was four hours and fifteen minutes. As the patient was being transferred

from the operating table to the stretcher at the conclusion of the operation, he said, "This has been better than a Marx Brothers' comedy." The evening of the operation, he talked well and moved all extremities well. He was discharged on the eleventh postoperative day, improved. Permanent section of the biopsy was diagnosed spongioblastoma multiforme. He was referred postoperatively to a radiologist for *x*-ray therapy. Two and one-half months following operation, he had two generalized convulsive seizures. None has occurred since. It is now eight months since his operation. He has had no headaches, feels well, his decompression is fairly soft and pulsates, and his optic disc margins are distinct. He has become economically rehabilitated.

REMARKS

It is impossible to state with accuracy from a neurosurgeon's viewpoint, that any glioma has been completely removed. The pathologist's report at postmortem has convinced us of this. Therefore, we refer all postoperative glioma cases to a radiologist for courses of deep *x*-ray therapy, and we are convinced that the continued well being of the above cases is due in no small measure to the influence of the *x*-rays in retarding or preventing further growth of whatever remains of the tumor cells.

Inasmuch as glioblastoma multiforme tumors possess no capsule, either of connective tissue or of glial tissue, it is imperative that in attempting complete extirpation surgically, the cerebral tissue excised should extend for at least a centimeter or better at all points beyond the visible margin of the growth. After removal, a thorough "cooking" of the walls of the remaining crater should be carried out with the electric cautery.

We believe that in every case of glioma a large subtemporal decompression should be done, irrespective of whether or not the tumor be removable. We realize that this procedure may hasten the growth of the irremovable tumors, but the beneficial effect that decompression has on the headaches and general well being of the patients out-weighs this disadvantage.

In the case of subcortical growths which unfortunately greatly preponderate, a lobectomy may be attempted but the relatives' attitude toward the end result must be weighed carefully against the surgeon's heroism.

SUCCESSIVE, COEXISTENT TUBAL PREGNANCIES*

CASE REPORT

R. M. MITCHELL, M.D.
Resident Physician, Obstetrics and Gynecology, Greenpoint Hospital

AND

LAWRENCE KURZROK, M.D.
Associate Attending Gynecologist, Greenpoint Hospital

BROOKLYN, NEW YORK

SINCE H. R. Fishback[1] reviewed the literature (1939) there have appeared four additional case reports of bilateral tubal pregnancy to add to the growing list, bringing the total of accepted cases to eighty. The latest case was reported by Cox and Steinberg.[2] To this number we wish to add an additional instance of "successive, coexistent tubal pregnancy."

The preoperative diagnosis was (a) chronic pelvic inflammatory disease, (b) fibroid tumor of the uterus, and (c) ectopic pregnancy was considered but the diagnosis was not definitely established prior to surgery. A left tubal pregnancy undergoing tubal abortion was found at operation and upon further inspection it was determined that the supposed fibroid of the uterus was another ectopic pregnancy involving the interstitial portion of the right tube.

CASE REPORT

The patient, a thirty-one year old white female, entered Greenpoint Hospital July 15, 1942. She was gravida VI, para III, all normal deliveries; her youngest child was three years old. Two criminally induced abortions in June, 1940, and February, 1941, had been performed; the postoperative course was uneventful in each case. Onset of menstruation was at thirteen years; it occurred every six weeks and lasted for six days; the flow was heavy the first three days and there was no dysmenorrhea. The last normal menstrual period occurred April 30, 1942. The previous periods were normal. The past history was irrelevant.

The patient first sought medical advice during the first week of July, 1942, because of prolongation of her period and the onset of left lower quadrant pain—"cramps." The menstrual abnormality started on May 15, 1942, at which time she flowed for six days (two weeks after last normal period). The bleeding ceased and started again on June 26, 1942; the flow was moderate in amount and continued until the date of admission.

Physical examination revealed a well developed, well nourished white female not acutely ill; pulse 78, temperature 98.6°F., respirations 16 per minute and blood pressure 110/64.

General examination was negative. The abdomen was flat, no masses were palpable; tenderness was present in the left lower quadrant. No inguinal adenopathy was noted. Vaginal examination was done. The external genitals were normal, introitus parous and pelvic support good. There was no evidence of infection in Bartholin's glands or Skene's ducts. The cervix pointed posteriorly and was lacerated slightly. The corpus uteri was retroverted but freely mobile and could be replaced; the uterus was enlarged to the size of a six weeks' gestation and was firm in consistency; a firm irregularity in the right midportion of the fundus uteri about 3 cm. by 3 cm. in diameter was felt. This appeared to be a solitary fibroid. A left adnexal mass was palpable, cystic in consistency and twice the size of a normal ovary. The right adnexa was palpable and essentially normal. Laboratory findings were as follows: red blood cells, 4,480,000; white blood cells, 8,300, hemoglobin, 82 per cent; sedimentation time, one hour plus; urine, negative; and the Wassermann and Kline tests were negative.

A low midline incision was made through the abdominal wall. On opening the peritoneal cavity free blood was visible, the amount present was about 500 cc. The left tube was found enlarged in the region of the ampulla, congested, tense, shiny and spindle-shaped. The ostium of the tube was patent and evidence of recent hemorrhage through that opening

* Title used by Behney and Hanes in their case report.

present; clots were removed from the tube. There was no evidence of external rupture of the tube at any point. A recent corpus luteum was present in the left ovary. The corpus of the uterus was found to contain a mass 2 cm. by 2½ cm. in diameter involving the right cornu and interstitial portion of the right tube. Its surface was multicolored, smooth and glistening, and again there was no evidence of rupture in the wall. Upon opening this tumor a small cavity was exposed and a rough surfaced dark brown mass—old clot—was extruded. The right ovary was found to be essentially normal. A bilateral salpingectomy was performed. The abdomen was closed in layers. The wound expectancy was clean.

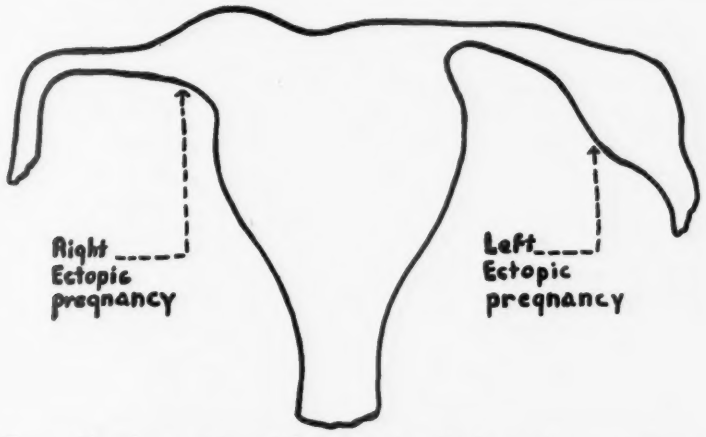


FIG. 1. Showing position of the above described ectopic pregnancies.

Pathological examination by Dr. Rosa Aranoff: "Grossly, the specimen consists of both Fallopian tubes and two irregular pieces of tissue. One tube (right) measures 5 cm. by 0.5 cm. in diameter and reveals a smooth, glistening yellow-pink external surface with an occasional thin-walled distended vessel. The fimbriated extremity is patent. The lumen of the tube is free, the surrounding wall is soft gray-white in color. The other tube (left) is somewhat kinked, measures 5 cm. by 1.5 cm. in diameter. The external surface is smooth, glistening, bluish-gray, covered in places by dry, friable brownish material. The fimbriated extremity is patent. In the cut surfaces of the distal two-thirds the lumen is occupied by soft to firm red-brown jelly-like material merging with the surrounding wall. One of the accompanying portions of tissue measures 2½ cm. by 2 cm., is firm in consistency, and contains an irregular previously emptied cavity about 1 cm. in diameter, the inner surface of which is covered with a yellow-gray in color. The other portion of tissue measures 2 cm. by 1½ cm. and is made up of material similar to that lining the cavity.

"Microscopically, in a preparation from the right Fallopian tube the lumen is traversed by characteristic slender branching folds, lined by tall cylindrical epithelium. The underlying wall is narrow for the most part with engorged vessels in places. Section from the left Fallopian tube shows a wide lumen filled with clotted blood containing occasional degenerated chorionic villi and scattered groups of preserved Langhans cells. The mucous folds are partly missing and widely separated from one another. The underlying wall is spread apart in places by accumulations of small round cells, large mononuclears, neutrophile polymorphonuclears as well as erythrocytes. Here and there synctial buds are noted. Parts of the external surface are covered by extravasated blood. In a preparation including the grossly described irregular cavity, the latter reveals a jagged surface bordered in parts by low cylindrical epithelium and containing an occasional similarly lined connective tissue fold. The surrounding and underlying tissue is loose, cellular or more densely fibrous, infiltrated in places with numerous small round cells, large mononuclears many of which are laden with yellow-brown granular material and in some areas with extravasated blood. Embedded in this stroma are scattered hyalinizing chorionic villi; merging with this is a broad layer of fibromuscular tissue with prominent focal perivascular infiltration by chronic inflammatory cells. Section

from the accompanying portion of tissue is made up of clotted blood with a few embedded degenerated chorionic villi."

The diagnosis was, "tubal pregnancy, bilateral, aborted recently on the left and at an earlier date on the right."

The postoperative course was uneventful and the patient was discharged on her twelfth postoperative day.

REMARKS

Lee and Stone[3] consider bilateral simultaneous tubal pregnancy still "sufficiently rare to justify reporting any verified case." Torpin[4] pointed out and others agree that bilateral simultaneous tubal pregnancy must be considered a form of double ovum twin pregnancy. This case again illustrates the necessity of inspecting both adnexa at the time of operation as pointed out by Behney and Hanes.[5] It also is representative of the point they wish to make in using the title "successive, coexistent tubal pregnancy" for it would definitely appear from gross inspection of these tubal pregnancies that the left side was several weeks younger than the condition that existed in the right tube. Further, in retrospective consideration of the patient's history one can fit the clinical picture to the gross pathological findings. Apparently the interstitial ectopic pregnancy caused the patient's menstrual upset May 15, 1942, and the ampullary ectopic pregnancy caused her complaints at admission. Microscopically, such a course of reasoning is confirmed. This case again seems to follow the general rule that in cases of bilateral tubal pregnancy there is seldom an indication from the history or physical findings that such a condition existed. This patient was evaluated as an intelligent woman.

We wish to express our appreciation to Dr. Thurston S. Welton, Director, Obstetrics and Gynecology, Greenpoint Hospital, Brooklyn, New York, for granting permission to use this case.

REFERENCES

1. Fishback, Hamilton R. *Am. J. Obst. & Gynec.*, 37: 1035, 1939.
2. Cox, M. E. and Steinberg, M. Ibid., 43: 120, 1942.
3. Lee, G. E. and Stone, Eugene, T. R. Ibid., 40: 316, 1940.
4. Torpin, Richard. Ibid., 39: 345, 1940.
5. Behney, C. A. and Hanes, W. J. Ibid., 40: 316, 1940.

RAT-BITE FEVER*

CASE REPORT

SAMUEL B. BURK, M.D.
Attending Surgeon, Misericordia Hospital

AND

JOSEPH H. HODAS, M.D.
Associate Attending Physician, Misericordia Hospital

NEW YORK, NEW YORK

IN the past few years the term, rat-bite fever, has been divided into two definite and distinct diseases, each with a specific organism as the causative agent. Because of special technics and methods of isolation, more cases have been recently proved and the clinical picture of both has become clearer and better understood.[1]

Sodoku, the older, better known, endemic type, is caused by a Spirochaete—the Spirillum minus. The more recently investigated disease, both endemic and epidemic, known as "Haverhill Fever" is caused by the Streptobacillus moniliformis.[2] Both Sodoku and Haverhill Fever are usually transmitted by rat bite but the latter has also been transmitted by contaminated food and drink.[3,4] The bite of a dog, cat, mouse, weasel, and skunk have also been reported as sources of entry.[5]

The clinical symptoms in both diseases are different.[6] Haverhill Fever has a shorter incubation period (from two to ten days), prompt wound healing, severe septic symptoms with arthritis, petechial rash, high fever, marked leucocytosis and no response to antispirochetal therapy. In contrast the spirillum type of infection has a longer incubation period (up to three weeks), a chancre-like initial lesion, lymphadenitis, delayed general symptoms, relapsing fever, slight leucocytosis, and responds well to specific antispirochetal therapy.

The *Sodoku* type of infection is comparatively rare; only 125 cases having been reported up to January, 1942.[7] It was found in twenty-eight states and the District of Columbia in the United States. It is especially prevalent in Japan where it was first described by Miyake.[5]

We present another case of Sodoku in this series with typical history and incubation period, positive clinical and laboratory findings, and favorable response to therapy.

CASE REPORT

Miss A. K., a white female, sixty-five years old, was admitted to the Surgical Service of Misericordia Hospital, New York City, with a history of pain and swelling on the right side of the upper lip of twenty-four hours' duration. She stated that she had been bitten by a rat nine days prior and the wound had been cauterized by her physician on the day after the bite. The wound had healed well with no apparent complications until the day before admission when it became red and swollen. At this time she developed high fever and joint pains, nausea and vomiting.

Examination on admission disclosed two small, apparently healed, purple puncture wounds just above the mucosa on the right side. Surrounding this, there was a red area of induration and swelling about the size of a walnut. The wound was painful to touch but there was no fluctuation. The submaxillary glands on the right side were enlarged and tender.

The patient ran a temperature of between 102 and 104°F. for three days and then the temperature fell by crisis to 100°F. Here it remained for three days more, and at this time the discoloration of the wound became deeper and the puncture wounds ulcerated, although no pus was present. Her temperature rose to 102°F. and subsequently went to 104°F. The patient became semicomotose, refused fluids and food and appeared quite ill. No exanthema was present.

Because of the patient's serious condition, neoarsphenamin[9] was administered with a marked response. The patient's temperature fell to normal the next day, the induration and discoloration became lessened, and the temperature did not recur. Three doses of neoarsphena-

* From the Surgical Service of Dr. S. B. Burk, Misericordia Hospital, New York City.

min were administered intravenously at five-day intervals, the initial dose being .15 mg. The induration disappeared but the puncture wounds were still open and draining. The patient, except for slight scarring of the lip recovered uneventfully.

Laboratory findings were as follows: Urine: a trace of albumin; leucocytes—5 to 10 per high power field, red cells 1 or 2. On May 29, 1938, hemoglobin was 110 per cent; red blood cells 5,900,000; white blood cells, 12,150; polymorphonuclears—60 per cent; lymphocytes 40 per cent. On June 3rd, white blood cells were 13,300; polymorphonuclears 85 per cent; lymphocytes 15 per cent. Wassermann report on June 3rd was negative. Blood culture was sterile. The culture from wound was negative at first but later showed hemolytic staphylococci (probably a secondary invader). A smear taken directly from the ulcerated wound (dark field examination) was reported by the Department of Health as positive for Spirillum.

REMARKS

We notice an incubation period of about a week with complete healing of the wound and no systemic symptoms. In the series of cases reviewed, the incubation period was usually from one to sixty days and averaged about two weeks. The febrile attacks usually last two or three days and one or more are characteristic. The rash usually does not appear until the fourth paroxysm of fever. In our case it probably did not appear because of the early administration of neoarsphenamin. The interval usually varies from two to fourteen days with amelioration of the local symptoms. With the onset of the febrile attack, pain and swelling are marked around the local lesion which resembles a chancre or the initial lesion of tuleremia. In typical cases, glandular involvement and lymphadenitis are usually present. The exanthema, about which much has been written, consists usually of red or bluish red macules, 3 to 10 cm. in size, and at times even resemble the rash of measles.

DIAGNOSIS

The diagnosis can usually be made by the following factors: (1) History of bite or scratch (there must be a break in the continuity of the skin); (2) symptomless incubation period of about one day to six weeks; (3) local signs and symptoms with a breaking down and ulceration of the lesion just preceding and during the febrile attack; (4) afebrile period of from two to seven days with apparent healing of initial lesion; (5) repeated bouts of fever; (6) therapeutic response to neoarsphenamin which usually requires from one to twelve intravenous injections. (7) The Wassermann and Kahn tests were negative in this case, both during and subsequent to the actual infection, possibly because of early and adequate therapy. Other investigators have recently found some changes in these reactions.[8] (8) The diagnosis is usually proved by the injection of the patient's blood into a guinea pig or mouse which has previously been examined and found negative for the Spirillum. The optimum time for examination of the infected animal seems about twenty days after injection.[10] Direct dark field examination and puncture of glands is also used but with less apparent success than with the above method. Examination of smears should be made about one hour after the blood is placed on the smear.

This comparatively rare disease usually has a mortality of about 10 per cent. However, with early clinical recognition, adequate laboratory work-up, and sufficient specific therapy, this mortality can be markedly reduced if not completely eliminated.

REFERENCES

1. Hart, A. D. Jr. *Virginia Med. Month.*, 68: 582–584, 1941.
2. Wooley, Paul V. Jr. *J. Pediat.*, 19: 515–525, 1941.
3. Parker and Hudson. *Am. J. Pathol.*, 2: 357, 1926.
4. Place and Sutton. *Arch. Int. Med.*, 54: 659, 1934.
5. Bayne-Jones, S. *Internat. Clin.*, 3: 235, 1931.
6. Ferrel, E. et al. *Arch. Int. Med.*, 64: 1, 1939.
7. Brown, Thomas McP. and Nunemaker, John C. *Bull. Johns Hopkins Hosp.*, 70: 201–334, 1942.
8. Allbritten, F. F. et al. *J. A. M. A.*, 114: 2360, 1940.
9. O'Leary, P. A. *Arch. Dermat. & Syph.*, 9: 293, 1924.
10. Garvin, J. A. *Ohio State M. J.*, 33: 1235, 1937.

AUTHOR INDEX TO VOLUME LX

Adams, E. Lawrence, 105
Al Akl, F. M., 248
Albee, Fred H., 349
Allen, Frederick M., 335
Auerbach, S. F., 235

Bachhuber, Carl A., 96
Basom, W. Compere, 151
Berson, Morton I., 101
Berwald, William P. E., 447
Bettman, Ralph Boerne, 243
Bird, W. Edwin, 81
Birnkrant, Milton, 182
Bolen, H. Leonard, 289
Breck, Louis W., 151
Bruckner, John P., 292
Buch, Irwin M., 396
Burk, Samuel B., 453
Buxton, R. W., 252

Capps, Richard B., 433
Carlucci, Gaston A., 209
Case, James T., 159
Castleton, Kenneth B., 190
Chapman, Jean L., 286
Cohen, Ira, 36
Cole, Lewis Gregory, 3
Conway, John F., 386
Cottis, G. W., 204

Dealy, Frank N., 63
Demakopoulos, Nicholas, 76
Denker, Peter G., 13
Di Lorenzo, Costabile, 319
Dobelle, Martin, 130
Dorman, Daniel B., 403
Drysdale, H. Raymond, 122

Echols, Dean H., 134
Eger, S. A., 140

Foster, George C., 2

Gladden, James R., 277
Gold, I. Roy, 144
Goldberg, Samuel L., 255
Goodman, Charles, 196
Grace, Edwin J., 361
Gratch, I., 411
Grayzel, David M., 144

Haines, Charles, 119
Hayden, Reynolds, 161
Hellendall, Hugo, 22
Herrlin, John, Jr., 126
Hodas, Joseph H., 453
Hooker, Donald H., 88
Howes, William E., 182
Howley, Clarence, 319

Janota, Martha, 371
Jensen, D. Rees, 301
Jensen, R. M., 429
Johnston, W. M., 313
Joldersma, R. D., 50
Joseph, Edward G., 381

Kaplan, Abraham, 36
Kennedy, Foster, 13
Kernwein, Graham A., 433
Kleinsasser, L. R. J., 134
Kurzrok, Lawrence, 450

Large, Octavus P., 415
Laufman, Harold, 243
Lawrence, Joseph, 264
Lev, Maurice, 115
Lewin, Philip, 371
Love, Carruthers, 264
Lubin, Samuel, 298

Macdonald, Dean, 122
Martland, Harrison S., 424
Masland, H. C., 154
Massell, Theodore B., 142
McCrea, Lowrain E., 328
McLaughlin, Edward F., 311
Mersheimer, Walter L., 126
Mietus, A. C., 399
Miley, George, 354
Mitchell, R. M., 399, 450
Mossman, H. W., 286

Norment, W. B., 56

Olsman, Louis, 115
Osborne, Raymond, 13

Phillips, John Roberts, 137
Posner, A. Charles, 396
Pugh, H. L., 429

Rankin, L. M., 140
Ritter, Henry H., 112
Robillard, G. L., 235
Ross, Charles A., 386
Rothman, Milton, 292, 319, 443
Rumold, Mervin J., 149

Sachs, Allan E., 255
Scheman, Louis, 371
Shapiro, A. L., 235
Sideman, Sidney, 371
Simon, Max Michael, 212
Sloane, David, 272
Smith, Roland T., 438
Stevens, N. C., 365

Tepper, Gilbert B., 142
Thatcher, Herbert H., 44
Thompson, Malcom, 1
Toman, Andrew J., 270
Totten, H. P., 227

Waltman, Richard, 298
Waugh, Richey L., 309
Waugh, W. Grant, 231
Weaver, James B., 149
Weeks, Richard B., 260
Weinshel, Leo R., 76
Weinstein, M. L., 105, 267
Welch, Esther M., 309
White, M. L., Jr., 252
Whittington, Claude T., 304
Wilensky, Abraham O., 221
Williams, Henry Ward, 447

Young, George G., 260

Zetena, Dominick F., 292, 443

SUBJECT INDEX TO VOLUME LX

(Bo. B.) = Bookshelf Browsing; (E.) = Editorial

Abdomen
  auscultation of, in appendicitis, 365
  injuries to, 319
  surgery of (E.), 1
Abscess, myocardial, and perforation of heart, 277
Actinomycosis of liver and lungs, 438
Adenitis, cervical, tuberculous, 231
Ampulla, carcinoma of, 137
Amputation of buttock, 149
Anastomosis
  gastrojejunal, and Rankin clamp, 227
  of pancreatic duct and jejunum, 137
Anesthesia
  avertin, in gynecology, 403
  caudal, in obstetrics, 399
  continuous, caudal, 396
  deaths caused by, 63
Anorectum, pain of, due to ovarian cyst, 289
Anuria, sulfathiazole, 105
Appendicitis, auscultation of abdomen in, 365
Argentaffinomas in ileum, 144
Army, localization and extraction of foreign body by, 3
Artery, thyroid, inferior, 96
Asphyxia during gunshot surgery, 270
Auricle, reconstruction of, 101
Auscultation of abdomen in appendicitis, 365
Avertin in gynecology, 403

Bacillus proteus OX19, 411
Blast, water, and injury, 429
Blood
  irradiation of, 354
  vessel suture, 196
Body, foreign, localization and extraction of, 3
Bone plating, fallacies of, 50
Book Reviews:
  Blood Substitutes and Blood Transfusion, 306
  Clinical Anesthesia—A Manual of Clinical Anesthesiology, 307
  First Aid—Surgical and Medical, 307
  Fractures, 308
  Hemorrhagic Diseases and the Physiology of Hemostasis, 306
  Human Embryology, 307
  Medical Parasitology, 308
  Miracles of Military Medicine, 307
  Obstetrical Practice, 156
  Oxford Medical Outline Series, 308
  Principles and Practice of Medicine, 156
  Psychotherapy in Medical Practice, 307
  Religion and Health, 306
  Sulfanilamide and Related Compounds in General Practice, 307
Boric acid, dangers of, 381
Brain injuries (E.), 159
Breast, tumors of, 235
Breasts, supernumerary, 76
Brooklyn Cancer Institute, melanoma at, 182
Brucella spondylitis, 130
Burn therapy (E.), 311
Buttock, amputation of, 149

Canal, uterine, study of, 56
Cancer
  of breast, 235
  of lung and smoking, 361
Carcinoma
  and torsion of cord, 304
  multiple, 22
  of ampulla, 137
Casualties, battle, 161
Cauda equina, tumors of, 36
Caudal anesthesia, continuous, 396, 399
Cecum
  rupture of, 142
  volvulus of, 292
Children, ovarian cysts in, 140
Chordoma, sacrococcygeal, 115
Clamp, Rankin, and anastomosis, 227
Clavicles, fractured, shoulder lift for, 154
Colon
  ascending, volvulus of, 292
  neoplasm of, 126
  splenic, obstruction of, 142
Color in operating room (E.), 309
Complications of thyroid surgery, 96
Control of thrombophlebitis, 354
Cord, torsion of, and undescended testicle, 304
Cyst, solitary, of kidney, 328
Cysts
  of sacrococcyx, 260
  ovarian, and anorectal pain, 289
    in children, 140
  pilonidal, 264

Dangers of boric acid, 386
Deaths, anesthetic, 63
Decapsulation of kidneys, 105
Deformity, Madelung's, 272
Dembrol hydrochloride, 267
Dilatation of stomach, 381
Diverticulum
  Meckel's, 443
  of sigmoid, 119
Drainage, peritoneal, 204
Drill, saw and Kirschner wire drill guide, 151
Duct
  bile, exploration of, 88
  common, reconstruction of, 209
Duodenum
  excision of, 137
  pancreatic nodule in, 286

Eradication of hemangioma, 149
Event, historical, and a great physician (E.), 160
Excision of duodenum and head of pancreas, 137
Exploration of common bile duct, 88
Extraction of foreign body, 3

Fallacies of bone plating, 50
Fallacy of peritoneal drainage, 204
Femur, intertrochanteric fractures of, 44
Fever
  rat-bite, 453
  scarlet, and thyroiditis, 301
  undulant, and spondylitis, 130
Fixation, internal, of fractures of femur, 44
Foreskin isografts, 255
Fractures
  clavicular, shoulder lift for, 154
  intertrochanteric of femur, 44
  of skull (E.), 159

Glioblastoma multiforme, 447
Guide, electric drill, 151
Gynecology, avertin in, 403

Healing in thoracoplasty wounds, 252
Heart, perforation of, 277
Hemangioma
  cavernous, of skull, 134
  of buttock, 149
Hemo-irradiation, thrombophlebitis and, 354
Hernia, Littré's, 81

Ileum, argentaffinomas in, 144
Injuries
  brain (E.), 159
  intestinal, caused by forceps, 424
  intra-abdominal, 319
Injury, water blast, 429
Intestine
  obstruction to, 443
  trauma to, during laparotomy, 424
Irrigant, boric acid as, 386
Isografts, foreskin, 255

Jaundice, medical, surgery for, 122

Kidney, solitary cyst of, 328
Kidneys, decapsulation of, 105
Knee, repair of ligaments of, 349

Laparatomy, intestinal, trauma during, 424
Larynx, nerve of, in thyroid surgery, 212
Ligaments of knee, repair of, 349
Ligation, saphenous, 248
Littré's umbilical hernia, 81
Liver
  actinomycosis of, 438
  metastasis to, 144
Lloyd-Davies technic in rectal resection, 243
Lobelin in asphyxia, 270
Localization of foreign body, 3
Lung
  actinomycosis of, 438
  cancer of, and smoking, 361

Madelung's deformity in sisters, 272
Management of tumors of breast, 235
Meckel's diverticulum and intestinal obstruction, 443
Melanoma, 182
Metastases in lymph nodes and liver, 144

Naval Hospital activities at Pearl Harbor, 161
Navy, surgical operations in, 313
Neoplasm, multiple, of colon, 126
Nerve
  laryngeal, in thyroid surgery, 212
    recurrent, 96
Nodes, lymph, metastasis to, 144
Nodule, pancreatic, in duodenum, 286

Obstetrics, caudal anesthesia in, 399
Obstruction
  intestinal, and Meckel's diverticulum, 443
  malignant, of splenic colon, 142
Operation, new, for repair of ligaments of knee, 349
Operations, surgical, in navy, 313
Osteomyelitis
  experimental, 371
  typhoid, 433
Ovary
  cysts of, and anorectal pain, 289
    in children, 140

Pain, anorectal, due to ovarian cyst, 289
Pancreas
  annular, 286
  head of, excision of, 137
Pearl Harbor Naval Hospital, 161
Perforation
  of diverticulum of sigmoid, 119
  of heart and staphylococcal pyemia, 277
Physician, a great (E.), 160
Plating of bone, 50
Polymastia, 76
Pregnancies, tubal, coexistent, 450
Pregnancy, abdominal, 298
Pseudomamma type of breasts, 76
Pyemia, staphylococcal, and perforation of heart, 277

Rankin clamp and anatomosis, 227
Rat-bite fever, 453
Reactions, tissue, from sutures, 415
Reconstruction
  of auricle, 101
  of common duct with vitallium tube, 209
Rectum, radical resection of, 243
Repair of ligaments of knee, 349
Resection, radical, of rectum, 243
Room, operating, color in (E.), 309
Rupture of cecum, 142

Sacrococcygeal cysts, 260
Sacrococcygeus, chordoma of, 115
Salt Lake City Hospitals, biliary surgery at, 190
Scarlet fever and thyroiditis, 301
Serum of pregnant women and bacillus proteus OX19, 411
Shock
  therapy of, 335
  treatment of, 112
Shoulder lift for fractured clavicles, 154
Sigmoid, diverticulum of, 119
Sisters, Madelung's deformity in, 272
Skull
  fractures (E.), 159
  hemangioma of, 134
Smoking and cancer of lung, 361
South Pacific, surgical operations in, 313
Spine, tumors of, 36
Spondylitis and undulant fever, 130
Sponge and tissue forceps injuries, 424
Stomach, dilatation of, 381
Study of uterine canal, 56
Suggestion (E.), 160
Sulfanilamide in perforation of sigmoidal diverticulum, 119
Sulfathiazole anuria, 105
Sulfonamides, use of, postoperatively (E.), 2
Surgery
  abdominal (E.), 1
  biliary, 88
    tract, 190
  for medical jaundice, 122
  gunshot, asphyxia during, 270
  thyroid, complications of, 96
    laryngeal nerve in, 212
Suture of blood vessel, 196

Sutures
and healing in thoracoplasty wounds, 252
new, and tissue reactions, 415

Technic of saphenous ligation, 248
Temperature, reduced, in shock, 335
Testicle, intra-abdominal, torsion of cord and carcinoma, 304
Therapy of shock, 335
Thyroiditis and scarlet fever, 301
Thyroid surgery, laryngeal nerve in, 212
Thrombophlebitis, control of, 354
Thyrotoxicosis and war effort, 221
Tissue reactions from new sutures, 415
Tract, biliary, surgery of, 190
Trauma, intestinal, caused by instruments, 424
Treatment
for dilatation of stomach, 381
of shock, 335
and fresh wounds, 112
surgical, of medical jaundice, 122
Tube, vitallium, in common duct, 209
Tubes, successive pregnancies in, 450
Tumors
of breast, 235
Tumors of cauda equina, 36
Typhoid osteomyelitis, 433

Ultraviolet blood irradiation, 354
Uterogram for study of uterus, 56
Uterus, study of, by observation on uterogram, 56

Vein
saphenous, ligation of, 248
thyroid, middle, 96
Vessel, blood, suture of, 196
Vitallium tube in common duct, 209
Volvulus, 443
of cecum and ascending colon, 292

War effort and thyrotoxicosis, 221
Water blast injury, 429
Wounds
fresh, treatment of, 112
thoracoplasty, healing of, 252

X-ray examinations in skull fractures and brain injuries (E.), 159

The American Journal of Surgery

PUBLISHED MONTHLY BY THE AMERICAN JOURNAL OF SURGERY, INC.
49 WEST 45TH STREET, NEW YORK, N. Y.

Editor: THURSTON SCOTT WELTON, M.D., NEW YORK

EDITORIAL BOARD

FRED H. ALBEE, *N.Y.*; CARL BECK, *Chicago*; CLAUDE S. BECK, *Clev.*; GEO. R. BRIGHTON, *N.Y.*; MEREDITH F. CAMPBELL, *N.Y.*; JAMES T. CASE, *Chicago*; ISIDORE COHN, *N.O.*; BRADLEY L. COLEY, *N.Y.*; FREDERICK A. COLLER, *Ann Arbor*; PAUL C. COLONNA, *Phila.*; ELLIOTT C. CUTLER, *Boston*; CHARLES A. ELSBERG, *N.Y.*; HERBERT C. FETT, *Brooklyn*; JOHN H. GIBBON, *Phila.*; EMIL GOETSCH, *Brooklyn*; CHARLES A. GORDON, *Brooklyn*; DONALD GUTHRIE, *Sayre, Pa.*; A. E. HERTZLER, *Kansas City*; LOUIS J. HIRSCHMAN, *Detroit*; J. M. HITZROT, *N.Y.*; FREDERICK C. HOLDEN, *N.Y.*; EMILE F. HOLMAN, *San Francisco*; JOHN E. JENNINGS, *Brooklyn*; W. L. KELLER, *Washington*; T. J. KIRWIN, *N.Y.*; ARTHUR KRIDA, *N.Y.*; A.V. S. LAMBERT, *N.Y.*; MAURICE LENZ, *N.Y.*; H. H. LYLE, *N.Y.*; JEROME M. LYNCH, *N.Y.*; URBAN MAES, *N.O.*; HARRISON S. MARTLAND, *Newark, N.J.*; RUDOLPH MATAS, *N.O.*; ROY D. MCCLURE, *Detroit*; H. C. NAFFZIGER, *San Francisco*; EMIL NOVAK, *Balt.*; CLARENCE R. O'CROWLEY, *Newark, N.J.*; LOUIS E. PHANEUF, *Boston*; EUGENE H. POOL, *N.Y.*; JAMES T. PRIESTLEY, *Rochester, Minn.*; DOUGLAS QUICK, *N.Y.*; N. P. RATHBUN, *Brooklyn*; HUBERT A. ROYSTER, *Raleigh*; HENRY S. RUTH, *Phila.*; M. G. SEELIG, *St. Louis*; J. BENTLEY SQUIER, *N.Y.*; H. J. STANDER, *N.Y.*; GRANT E. WARD, *Baltimore*; J. H. WOOLSEY, *San Francisco*.

NEW SERIES, VOLUME LX

APRIL TO JUNE

1943

THE AMERICAN JOURNAL OF SURGERY · INC · PUBLISHERS
NEW YORK MCMXLIII

COPYRIGHT, 1943
BY THE AMERICAN JOURNAL OF SURGERY, INC.
All Rights Reserved

Printed in the United States of America

CONTENTS OF NEW SERIES, VOLUME LX

ORIGINAL ARTICLES

Foreign Body Localization and Extraction. Description of a Method More Accurate than That Used by the Army	*Lewis Gregory Cole*	3
Early Laminectomy for Spinal Cord Injury Not Due to Subluxation	*Foster Kennedy*, *Peter G. Denker*, *Raymond Osborne*	13
Multiple Carcinoma. The Clinical Picture, Diagnosis and Prognosis	*Hugo Hellendall*	22
Tumors in the Region of the Cauda Equina. A Review of Twenty-five Cases	*Ira Cohen*, *Lieut. Comdr. Abraham Kaplan*	36
Internal Fixation Device for the Treatment of Intertrochanteric Fractures of the Femur	*Herbert H. Thatcher*	44
Fallacies of Bone Plating	*R. D. Joldersma*	50
Study of the Uterine Canal by Direct Observation and Uterogram	*W. B. Norment*	56
Anesthetic Deaths. A Five-year Report	*Frank N. Dealy*	63
Supernumerary Breasts. With Special Reference to the Pseudomamma Type	*Captain Leo R. Weinsbel*, *First Lieut. Nicholas Demakopoulos*	76
Littré's Umbilical Hernia. Case Report	*W. Edwin Bird*	81
Exploration of the Common Bile Duct. Review of 165 Cases	*Captain Donald H. Hooker*	88
Complications of Thyroid Surgery. Anatomy of the Recurrent Laryngeal Nerve, Middle Thyroid Vein and Inferior Thyroid Artery	*Carl A. Bachhuber*	96
Complete Reconstruction of Auricle	*Morton I. Berson*	101
Sulfathiazole Anuria Cured by Decapsulation of the Kidneys. Case Report	*M. L. Weinstein*, *E. Lawrence Adams*	105
Treatment of Shock and Fresh Wounds	*Henry H. Ritter*	112
Sacrococcygeal Chordoma. Report of a Case	*Louis Olsman*, *Maurice Lev*	115
Acute Perforation of a Diverticulum of the Sigmoid. Treatment by Operation and Sulfanilamide	*Charles Haines*	119
Surgical Treatment of Medical Jaundice. Case Report	*Dean Macdonald*, *H. Raymond Drysdale*	122
Multiple Primary Neoplasm of the Colon	*John Herrlin, Jr.*, *Walter L. Mersheimer*	126
Brucella Spondylitis. Case Report	*Martin Dobelle*	130
Cavernous Hemangioma of the Skull. Case Report	*Dean H. Echols*, *Captain L. R. J. Kleinsasser*	134
Excision of the Duodenum and Head of the Pancreas for Carcinoma of the Ampulla. Method of Anastomosing Pancreatic Duct to the Jejunum	*John Roberts Phillips*	137

Pedunculated Ovarian Cysts in Children. An Aid to Diagnosis	*L. M. Rankin* *S. A. Eger*	140
Rupture of the Normal Cecum Resulting from Malignant Obstruction of the Splenic Colon	*Gilbert B. Tepper* *Theodore B. Massell*	142
Multiple Argentaffinomas in Ileum with Metastases in Lymph Nodes and in the Liver	*I. Roy Gold* *David M. Grayzel*	144
Amputation of a Buttock for Eradication of a Cavernous Hemangioma	*James B. Weaver* *Mervin J. Rumold*	149
Inexpensive Electric Drill, Saw and Kirschner Wire Drill Guide	*W. Compere Basom* *Louis W. Breck*	151
Positive Shoulder Lift for Fractured Clavicles	*H. C. Masland*	154
Activities of the Naval Hospital at Pearl Harbor Following the Japanese Air Raid of December 7, 1941. Comments on the Care of Battle Casualties	*Captain Reynolds Hayden*	161
Melanoma. A Review of Thirty-two Cases Admitted to the Brooklyn Cancer Institute during a Five-year Period	*William E. Howes* *Milton Birnkrant*	182
Biliary Tract Surgery. Survey in Salt Lake City Hospitals 1930 to 1940 Inclusive	*Kenneth B. Castleton*	190
Blood Vessel Suture. Its Use Instead of the Ligature in War Surgery	*Charles Goodman*	196
Fallacy of Peritoneal Drainage	*G. W. Cottis*	204
Reconstruction of the Common Duct with a Vitallium Tube. Case Report	*Gaston A. Carlucci*	209
Recurrent Laryngeal Nerve in Thyroid Surgery. Triangle for Its Recognition and Protection	*Max Michael Simon*	212
Relationship of Thyrotoxicosis to the Present War Effort. Its Modern Treatment	*Abraham O. Wilensky*	221
Simplified Aseptic Gastrojejunal Anastomosis Using the Rankin Clamp	*H. P. Totten*	227
Tuberculous Cervical Adenitis. Treatment by Immobilization	*W. Grant Waugh*	231
Management of Tumors of the Breast. With Special Emphasis on the Problem of Cancer of the Breast	*G. L. Robillard* *S. F. Auerbach* *A. L. Shapiro*	235
One-stage Radical Resection of the Rectum by Modified Lloyd-Davies Technic	*Harold Laufman* *Ralph Boerne Bettman*	243
Technic of Saphenous Ligation	*F. M. Al Akl*	248
Relationship of Suture Material to Healing in Thoracoplasty Wounds	*R. W. Buxton* *M. L. White, Jr.*	252
Foreskin Isografts	*Allen E. Sachs* *Samuel L. Goldberg*	255
Sacrococcygeal Cysts. Report of 200 Cases in an Army Hospital	*Lieut. Col. Richard B. Weeks* *Captain George G. Young*	260

Pilonidal Cyst	*Captain David Brezin* *First Lieut. Carruthers Love* *First Lieut Joseph Lawrence*	264
Demerol Hydrochloride. A New Drug in the Practice of Surgery	*M. L. Weinstein*	267
Lobelin in Asphyxia during Gunshot Surgery	*Andrew J. Toman*	270
Madelung's Deformity in Sisters	*Major David Sloane*	272
Myocardial Abscess with Perforation of the Heart Following Staphylococcal Pyemia	*James R. Gladden*	277
Annular Pancreas. Accompanied by an Aberrant Pancreatic Nodule in the Duodenum.	*Jean L. Chapman* *H. W. Mossman*	286
Anorectal Pain Due to Follicular Ovarian Cyst	*H. Leonard Bolen*	289
Volvulus of the Cecum and Ascending Colon. With a Review of the Literature and Presentation of a case	*Milton Rothman* *John P. Bruckner* *Dominick F. Zetena*	292
Septic Abdominal Pregnancy Past Term	*Samuel Lubin* *Richard Waltman*	298
Acute Thyroiditis Complicating Scarlet Fever	*D. Rees Jensen*	301
Undescended Intra-abdominal Testicle with Torsion of the Cord and Embryonic Cell Carcinoma. Case Report	*Claude T. Whittington*	304
Surgical Operations with the Navy Medical Corps in the South Pacific	*Lieut. Comdr. W. M. Johnston*	313
Intra-abdominal Injuries	*Costabile Di Lorenzo* *Milton Rothman* *Clarence Howley*	319
Solitary Cyst of the Kidney. Report of Two Cases	*Lowrain E. McCrea*	328
Theory and Therapy of Shock. Reduced Temperatures in Shock Treatment	*Frederick M. Allen*	335
New Operation for the repair of the Crucial Ligaments of the Knee	*Fred H. Albee*	349
Control of Acute Thrombophlebitis with Ultraviolet Blood Irradiation Therapy	*George Miley*	354
Tobacco Smoking and Cancer of the Lung	*Edwin J. Grace*	361
Value of Auscultation of the Abdomen in the Diagnosis of Acute Appendicitis	*N. C. Stevens*	365
Experimental Osteomyelitis	*Louis Scheman* *Philip Lewin* *Sidney Sideman* *Martha Janota*	371
New Treatment for Acute Dilatation of the Stomach	*Edward G. Joseph*	381
Dangers of Boric Acid. Its Use as an Irrigant and Report of a Case	*Charles A. Ross* *John F. Conway*	386
Continuous Caudal Anesthesia. Preliminary Report of a Newly Modified Technic	*A. Charles Posner* *Irwin M. Buch*	396

Caudal Anesthesia in Obstetrics	*A. C. Mietus* *R. M. Mitchell*	399
Avertin Anesthesia in Gynecology. Report of a Series of Cases	*Lieut. Daniel B. Dorman*	403
Bacillus Proteus OX19 Agglutinated by the Serum of Pregnant Women. Preliminary Report	*I. Gratch*	411
Comparison of Tissue Reactions from New Sutures	*Octavus P. Large*	415
Instrumental Intestinal Trauma during Laparotomy. Sponge and Tissue Forceps Injuries	*Harrison S. Martland*	424
Water Blast Injury. Report of Two Unusual Cases	*Comdr. H. L. Pugh* *Lieut. R. M. Jensen*	429
Typhoid Osteomyelitis. Case Report	*Graham A. Kernwein* *Richard B. Capps*	433
Actinomycosis of the Liver and Lungs	*Roland T. Smith*	438
Meckel's Diverticulum as a Cause of Intestinal Obstruction. Report of a Case of Volvulus	*Milton Rothman* *Dominick F. Zetena*	443
Glioblastoma Multiforme. Report of Three Cases	*Henry Ward Williams* *William P. E. Berwald*	447
Successive, Coexistent Tubal Pregnancies. Case Report	*R. M. Mitchell* *Lawrence Kurzrok*	450
Rat-bite Fever. Case Report	*Samuel B. Burk* *Joseph H. Hodas*	453

RED CROSS COTTON

Sterile—Pure—Absorbent

• You will find Red Cross Cotton (Purified Cotton—U. S. P. XII) suitable for your most exacting requirements. Sterile, pure, absorbent, soft and fluffy. Supplied in convenient-size dispensing cartons up to 1-pound. **ORDER FROM YOUR DEALER**

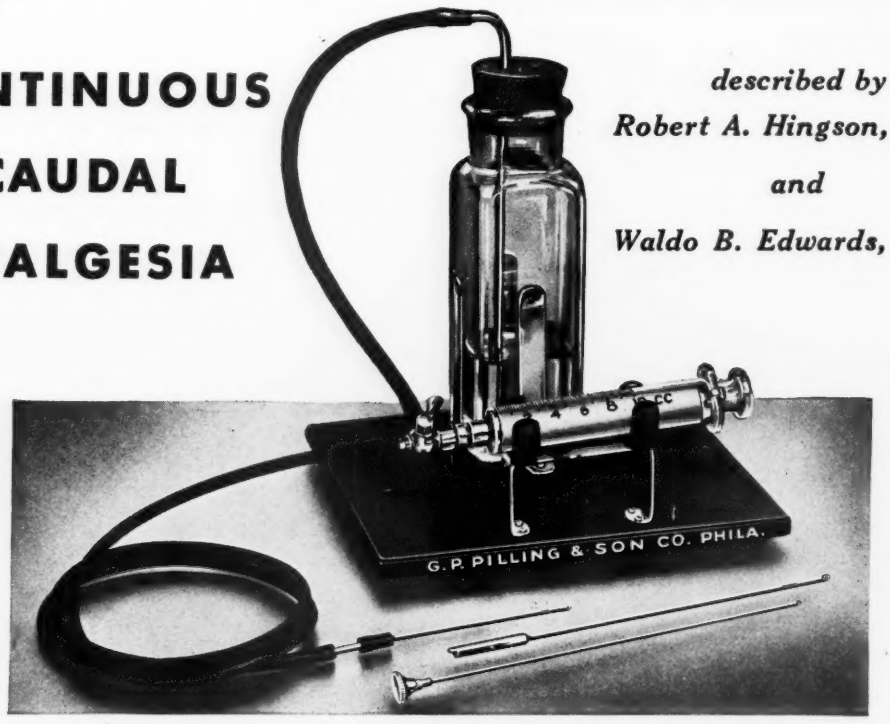
Johnson & Johnson

NEW BRUNSWICK, N. J. CHICAGO, ILL.

ARMY E NAVY

CONTINUOUS CAUDAL ANALGESIA

described by
Robert A. Hingson, M. D.
and
Waldo B. Edwards, M. D.



MADE BY

THE GEORGE P. Arch & Twenty-third Sts. **PILLING** & SON COMPANY Philadelphia, Pa., U. S. A.

Gremlins **of sphygmomanometry**
. . . EXCESSIVE RATE OF FALL

Lifetime Baumanometer
STANDARD FOR BLOODPRESSURE

Get the **FACTS** and you will buy a Lifetime Baumanometer

It is common practice to increase pressure in the cuff in steps of approximately 10 mm. until the radial pulse disappears. Pressure is then increased 20-30 mm. to determine complete closure of the artery. It is common knowledge that should the rate of fall exceed 2-3 mm. per second, a lag error may result, even in a properly constructed mercurial instrument . . . but the possibility of an even greater error is introduced in *any type* apparatus with an excessive rate of fall, for by just missing a beat, a drop of 5-10 mm. may take place before the succeeding heartbeat is heard. Proper technique calls for a 2-3 mm. per second rate of fall of the indicator. Therefore, controlling the *release* of pressure is of paramount importance in accurate blood-pressure taking.

The inherent accuracy which is built into every individually calibrated Lifetime Baumanometer is at the disposal of all who demand consistently accurate bloodpressure readings. Any lag error caused by pressure compensation is readily avoided by keeping the rate of fall within the prescribed 2-3 mm. per second. The Baumanometer Air-Flo Control Valve facilitates accurate control in this important phase.

W. A. BAUM CO., INC. NEW YORK
ORIGINATORS AND MAKERS OF BLOODPRESSURE APPARATUS EXCLUSIVELY

GROWING UP WITH THE NATION

In 1876, the Philadelphia Centennial heralded the approach of the great industrial era. In the same city, a youthful organization was implanting its roots in the soil of American pharmacy. William Richard Warner, true to the pioneering spirit of his age, was even then evolving new and better methods of making medicinal drugs.

Over the years, the house of William R. Warner & Co., Inc. has grown until today its branches girdle the globe, in fulfillment of its early chosen motto, "Omnis Orbis." And, conscious of its obligation to play a worthy part in the progress of pharmaceutical science, the house of Warner, through its affiliated Warner Institute for Therapeutic Research, continues to pioneer in the pursuit of original investigation and research, to the end that still better, safer means may be found for the prevention and control of disease.

OMNIS ORBIS
WARNER
ESTABLISHED 1856

WILLIAM R. WARNER & CO., INC.

113 West 18th Street, New York • 404 South Fourth Street, St. Louis

Branches and Agencies in 75 foreign countries

THE NEW YORK POLYCLINIC
MEDICAL SCHOOL AND HOSPITAL
(ORGANIZED 1881)

(The Pioneer Post-Graduate Medical Institution in America.)

OBSTETRICS AND GYNECOLOGY

A full time course. In Obstetrics: lectures; prenatal clinics; witnessing normal and operative deliveries; operative obstetrics (manikin). In Gynecology: lectures; touch clinics; witnessing operations; examination of patients pre-operatively; follow-up in wards post-operatively. Obstetrical and Gynecological pathology. Regional anesthesia (cadaver). Attendance at conferences in Obstetrics and Gynecology. Operative Gynecology (cadaver).

EYE, EAR, NOSE and THROAT

A 3 months combined full-time refresher course consisting of attendance at clinics, witnessing operations, lectures, demonstration of cases and cadaver demonstrations; operative eye, ear, nose and throat on the cadaver; clinical and cadaver demonstrations in bronchoscopy, laryngeal surgery and surgery for facial palsy; refraction; roentgenology; pathology, bacteriology and embryology; physiology; neuro-anatomy; anesthesia; physical therapy; allergy; examination of patients pre-operatively and follow-up post-operatively in the wards and clinics.

FOR INFORMATION ADDRESS

MEDICAL EXECUTIVE OFFICER, 345 West 50th Street, NEW YORK CITY

COOK COUNTY
GRADUATE SCHOOL OF MEDICINE
(In affiliation with COOK COUNTY HOSPITAL) Incorporated not for profit

Announces continuous courses

SURGERY—Two Weeks Intensive Course in Surgical Technique starting June 28, July 12, July 26, and every two weeks throughout the year.

MEDICINE—Two Weeks Intensive Course starting October 4. One Month Course in Electrocardiography and Heart Disease starting the first of every month, except August. Two Weeks Course in Electrocardiography starting August 2.

FRACTURES & TRAUMATIC SURGERY—Two Weeks Intensive Course starting October 18.

GYNECOLOGY—Two Weeks Intensive Course starting October 18. One Month Personal Course starting August 2. Clinical and Diagnostic Courses.

OBSTETRICS—Two Weeks Intensive Course starting October 4.

OPHTHALMOLOGY—Two Weeks Intensive Course starting September 27. Course in Refraction Methods October 11.

OTOLARYNGOLOGY—Two Weeks Intensive Course starting September 13.

ROENTGENOLOGY—Courses in X-ray Interpretation, Fluoroscopy, Deep X-ray Therapy every week.

UROLOGY—Two Weeks Course and One Month Course available every two weeks.

CYSTOSCOPY—Ten Day Practical Course every two weeks.

GENERAL, INTENSIVE AND SPECIAL COURSES IN ALL BRANCHES OF MEDICINE, SURGERY AND THE SPECIALTIES

Teaching Faculty—Attending Staff of

COOK COUNTY HOSPITAL

Address: Registrar, 427 South Honore Street, Chicago, Illinois

EST. 1848

Haslam

Experience Makes the Master!

Constant striving, since 1848, to create better instruments, has enabled Fred Haslam & Co., Inc. to achieve an assured mastery of the Surgical Instrument-making art.

***Superior Quality* SURGEONS NEEDLES**

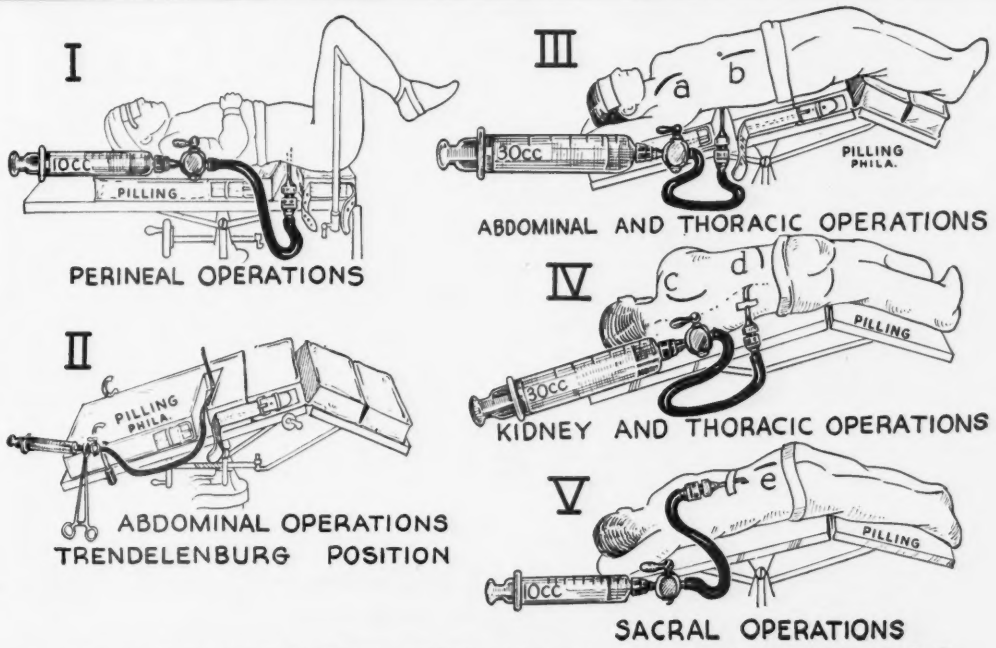
(Made in England)

Correct sizes and shapes of perfect, uniform temper . . . Highly polished . . . Sharp points, keen cutting edges and large bulgeless eyes.

Always Dependable ***Complete Needle Catalog on Request***

FRED HASLAM & CO., INC.

83 Pulaski St., Brooklyn, N. Y.



CONTINUOUS SPINAL ANESTHESIA

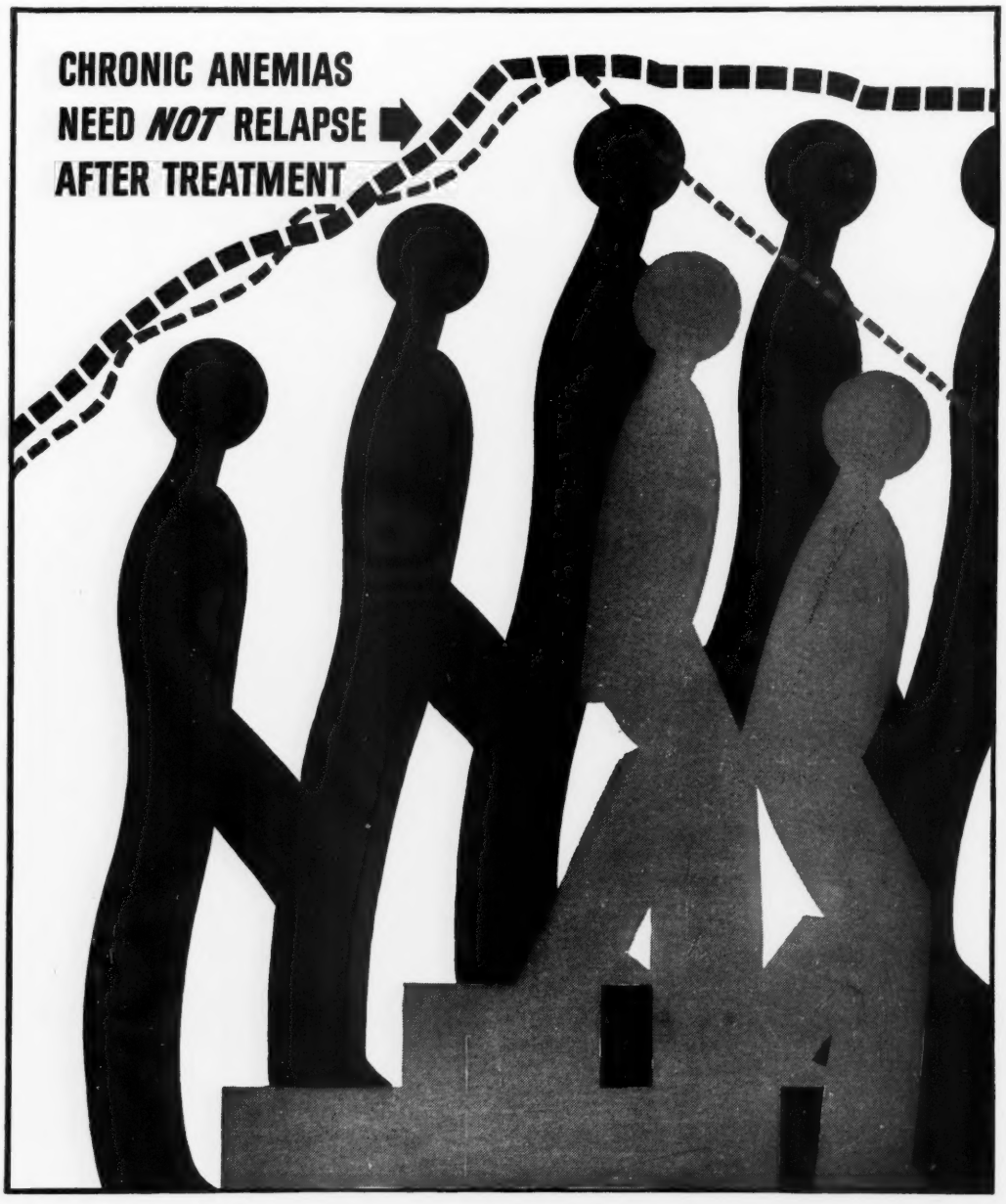
Described in the May, 1942, issue, Surgery, Gynecology and Obstetrics, pages 948-955. Surgical Clinics of North America, December, 1942. Designed by Wm. T. Lemmon, M.D., Jefferson Hospital, Philadelphia, used in a large variety of over 3000 operations. Can be used on any operating table.

Interesting reprint describing the technique and equipment sent on request

MADE BY SOLD BY

THE GEORGE P. PILLING & SON COMPANY

Arch & Twenty-third Sts. Philadelphia, Pa., U. S. A.



RAPID, COMPLETE RECOVERY FOLLOWS THE ADMINISTRATION OF BĒPRON*

"This recovery is lasting and is not followed by a relapse when the therapy is discontinued." Bepron's effectiveness in chronic anemias is independent of the diet of the patient.†

Wyeth's

BĒPRON BEEF LIVER WITH IRON

†GOTTLIEB, R. : Whole Liver as an Adjuvant to Iron in the Treatment of Hypochromic Anemia. Canad. M.A.J. 47 : 456 - 460 (Nov.) 1942.

*Reg. U. S. Pat. Off.

JOHN WYETH & BROTHER, INCORPORATED • PHILADELPHIA, PENNSYLVANIA

UNIVERSAL FRAC-SURE UNITS

By Tower - - - *using the Roger Anderson Technics*

- One type for all fractures of the extremities.
- Frac-Sure Unit Pin Clamps take any size pin, half pin or wire.
- Flexibility permits insertion of pins at any anatomically correct angle or position.
- Rods and Clamps of Frac-Sure Unit readily adjustable to any desired distance from tissues.
- Reduction with Frac-Sure Units can be done manually or with fracture table or Tower's Anatomic Reduction Splint.
- Light, rust-proof, durable, may be used repeatedly.
- Electrolytic reaction impossible.
- Frac-Sure Units will unlock locked fractures.
- Complete service equipment for application of the Roger Anderson technics in fracture treatment comes in compact light portable Frac-Sure Kit — (only about 20 pounds fully equipped).

Booklet on fracture technic furnished on request. NOTE TO MILITARY AND CIVILIAN DEFENSE HOSPITALS: Technicians available for demonstrating Universal Frac-Sure Equipment without obligation.

Total weight of Above Units 11 ounces

Sole Manufacturers and Distributors

The TOWER COMPANY Inc.
HOME OFFICE
1008 Western Ave.
Seattle, U. S. A.
MAin 4443
Cable Address "TICSEATTLE"

THE TOWER CO. INC.
SEATTLE, U.S.A.

The TOWER COMPANY DISTRIBUTORS Inc.
120 S. La Salle Bldg.
Chicago, Illinois
11 West 42nd Street
New York City, N. Y.

Manufacturing and Research Specialists in Fracture Equipment

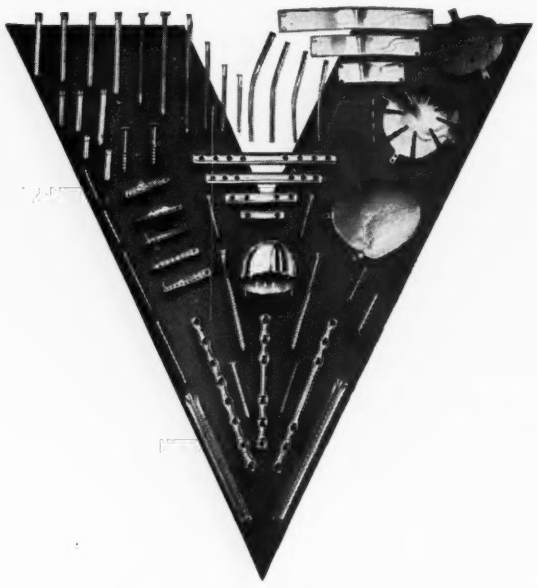
First Choice for *Sterilability

**ability to withstand sterilizations*

PRE-WAR *Quality*

Matex Last Longer

VITALLIUM
SURGICAL APPLIANCES



TRADEMARK REG. U. S. PAT. OFFICE

The only true Cobalt-Chromium alloy being used in bone surgery

VITALLIUM nails, screws, plates, hip caps and special appliances have an authentic operative and clinical success that is without parallel in the internal fixation of fractures.

Order through your dealer

*Campbell, W. C. and Speed, J. S., Annals of Surgery, 110-1. July, 1939. • Berry, H. C., Journal of Arkansas State Dental Association, 10-2. June, 1939. • Strock, A. E., American Journal of Orthodontics & Oral Surgery, 25-5. May, 1939. • Doherty, W. B., American Journal of Ophthalmology, 22-4. April, 1939. • Smith-Petersen, M. N., The Journal of Bone & Joint Surgery, 21-2, April, 1939. • Claflin, R. S., American Journal of Orthodontics & Oral Surgery, 25-1. January, 1939. • Hopkins, H. H. and Zuck, F. N., Medical Bulletin of Veterans' Administration, 15-3. January, 1939. • Venable, C. S. and Stuck, W. G., Journal of American Medical Association, 11-15. October 8, 1938.

AUSTENAL LABORATORIES, Inc.
NEW YORK • CHICAGO

Before the thread breaks

WHEN the thin thread of life is taut and fraying, numerous physicians find a respiratory stimulant of the first order in

LOBELIN-BISCHOFF

Acting primarily upon the respiratory center, LOBELIN-BISCHOFF lowers the CO_2 threshold so that the center is able to transmit impulses to the respiratory apparatus.

LOBELIN-BISCHOFF is indicated whenever a respiratory emergency arises. Its worth is supported by a wealth of laboratory and clinical experience. Write for literature.

ERNST **Bischoff** CO., INC.
IVORYTON · CONNECTICUT

"... a cod-liver oil ointment and ointments containing vitamins A and D from other fish-liver oils caused a much more rapid rate of healing than was observed in control lesions or burns treated with tannic acid."
Abramowitz, E. W.: Indus. Med., 10:481-486 (Nov.) 1941

WHITE'S VITAMIN A and D OINTMENT

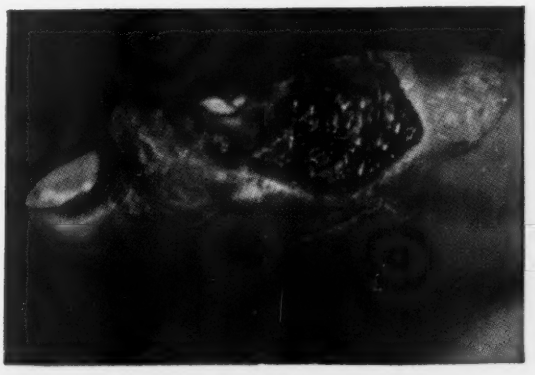
brings to the treatment of burns, wounds, ulcers and various skin affections the vitamins A and D of fish liver oils, in the same ratio as found in cod liver oil—incorporated in a lanolin-petrolatum base.

White's Vitamin A and D Ointment has a pleasant odor, is free from excessive oiliness. At ordinary temperature, will keep indefinitely without becoming rancid.

Topical application of vitamins A and D has shown many advantages:

1. Promotes healthy granulation and rapid epithelization
2. Reduces infection
3. Applicable to burns and wounds of any area—face, hands, perineum, axillae, groin
4. Minimizes the need for skin grafting

Four convenient sizes: 1.5 oz. tubes, 8 oz. and 16 oz. jars, 5 lb. containers.

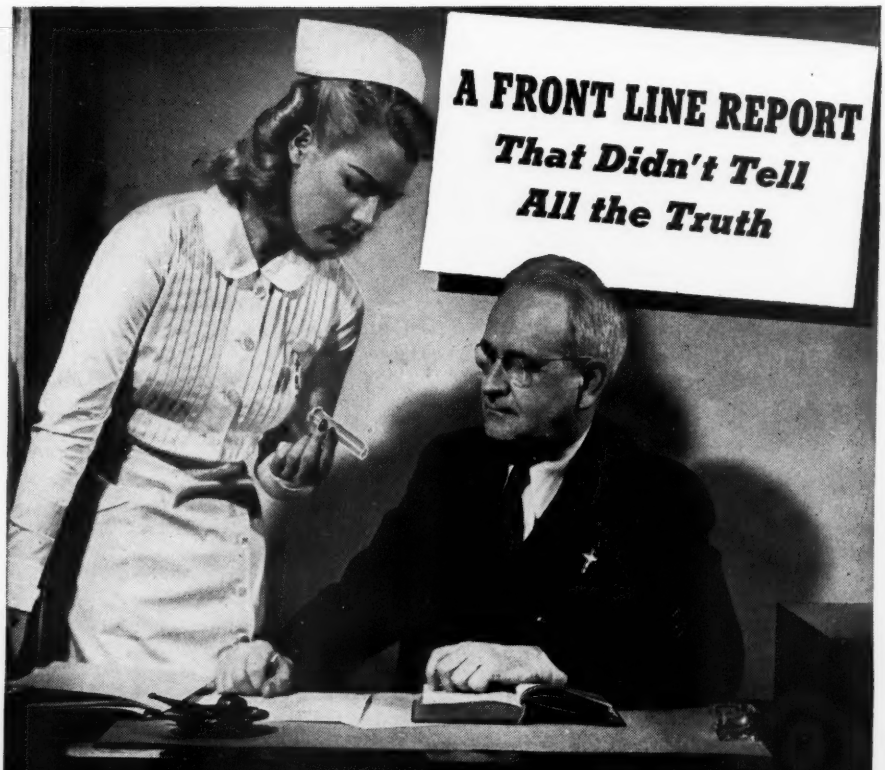


Deep electrical burn caused by 11,000 volt shock. Appearance at 3 weeks shows typical deep destructive process. Extensor tendon has sloughed out, distal interphalangeal joint is fully exposed, amputation appears necessary.

Appearance after 4½ weeks. Treatment consisted of dressings—infrequently changed—with White's Vitamin A and D Ointment and use of finger splint. Sloughing quickly cleared up, granulations filled in the extensive defect, with complete healing.

Ethically promoted—not advertised to the lay. White Laboratories, Inc., Newark, N. J.

White's PRESCRIPTION *vitamins*



"It broke in the sterilizer"...

How frequently you hear that explanation when a syringe meets an untimely end.

Perhaps you have come to accept it as "one of those things" which run up expenses but just can't be helped. Or perhaps, you want to know *all* the truth.

Every piece of glass which is shaped and heated acquires internal strains — weak spots where breakage occurs from heat or careless handling.

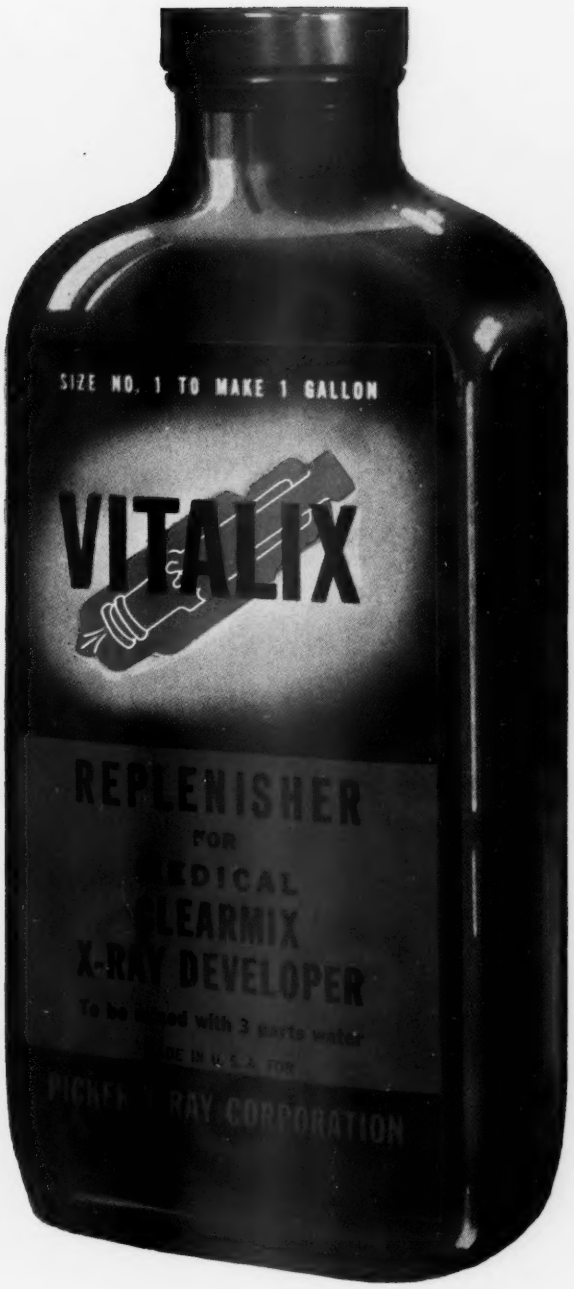
To eliminate these weak spots B-D Syringes are annealed after every heating operation and finally annealed complete in thermostatically controlled electric annealing ovens which remove every trace of strain.

Reduction of premature breakage is the objective. Long, economical service to you is the result.

B-D PRODUCTS
Made for the Profession

BECTON, DICKINSON & CO., RUTHERFORD, N. J.

Best by test



Reports from large and small x-ray laboratories prove the superiority of Vitalix Developer Replenisher under actual working conditions.

X-ray technicians in large hospital laboratories, as well as those identified with private practice, prefer Vitalix Developer Replenisher in the control of x-ray processing procedure.

Through the use of Vitalix Developer Replenisher, x-ray laboratories can now maintain processing schedules and secure uniform density in all radiographs at established developing time.

Vitalix Developer Replenisher insures full strength solutions consistently. It replaces the exhausted chemicals with new, fresh, active ingredients and gives your old developer a new lease on life.

To secure maximum radiographic detail in the greatest number of processed films, specify Vitalix Developer Replenisher, and to insure prompt delivery, place your order at once.

ARMY E NAVY

PICKER X-RAY CORPORATION
300 FOURTH AVENUE • NEW YORK. N. Y.

"A tooth in a silver leaf"...

In ancient Islam, it was believed that if a woman carried a tooth in a silver leaf, she would not conceive.*

● Superstition has been displaced in our enlightened world. Medical contraceptive practice today requires the selection of methods and materials that have been established on a scientific basis through technical and clinical research. The effectiveness of Ortho-Gynol can be attributed to the high degree of uniformity in the desirable physical and chemical properties. This is supported by satisfactory results obtained in extensive clinical studies.

*Himes—Medical History of Contraception

COPYRIGHT 1943, ORTHO PRODUCTS, INC., LINDEN, NEW JERSEY

The American Journal of Surgery

ADVERTISERS INDEX

Instruments and Apparatus

Austenal Laboratories, Inc.	32
Bard-Parker Co., Inc.	*May*
W. A. Baum Co., Inc.	26
Becton, Dickinson & Co.	34
Crescent Surgical Sales Co., Inc.	9
General Electric X-ray Corp.	*May*
Fred Haslam & Co., Inc.	29
Picker X-ray Corp.	35
Geo. P. Pilling & Son Co.	26, 29
Singer Sewing Machine Company	8
J. Sklar Manufacturing Co.	11
The Tower Co., Inc.	31
Edward Weck & Co., Inc.	7
Zimmer Manufacturing Co.	*May*

Sutures

Davis & Geck, Inc.	*Insert Facing 2nd Cover*
J. A. Deknatel & Son, Inc.	*May*
Gudebrod Bros. Silk Co., Inc.	10
Johnson & Johnson	24, 25

Pharmaceuticals

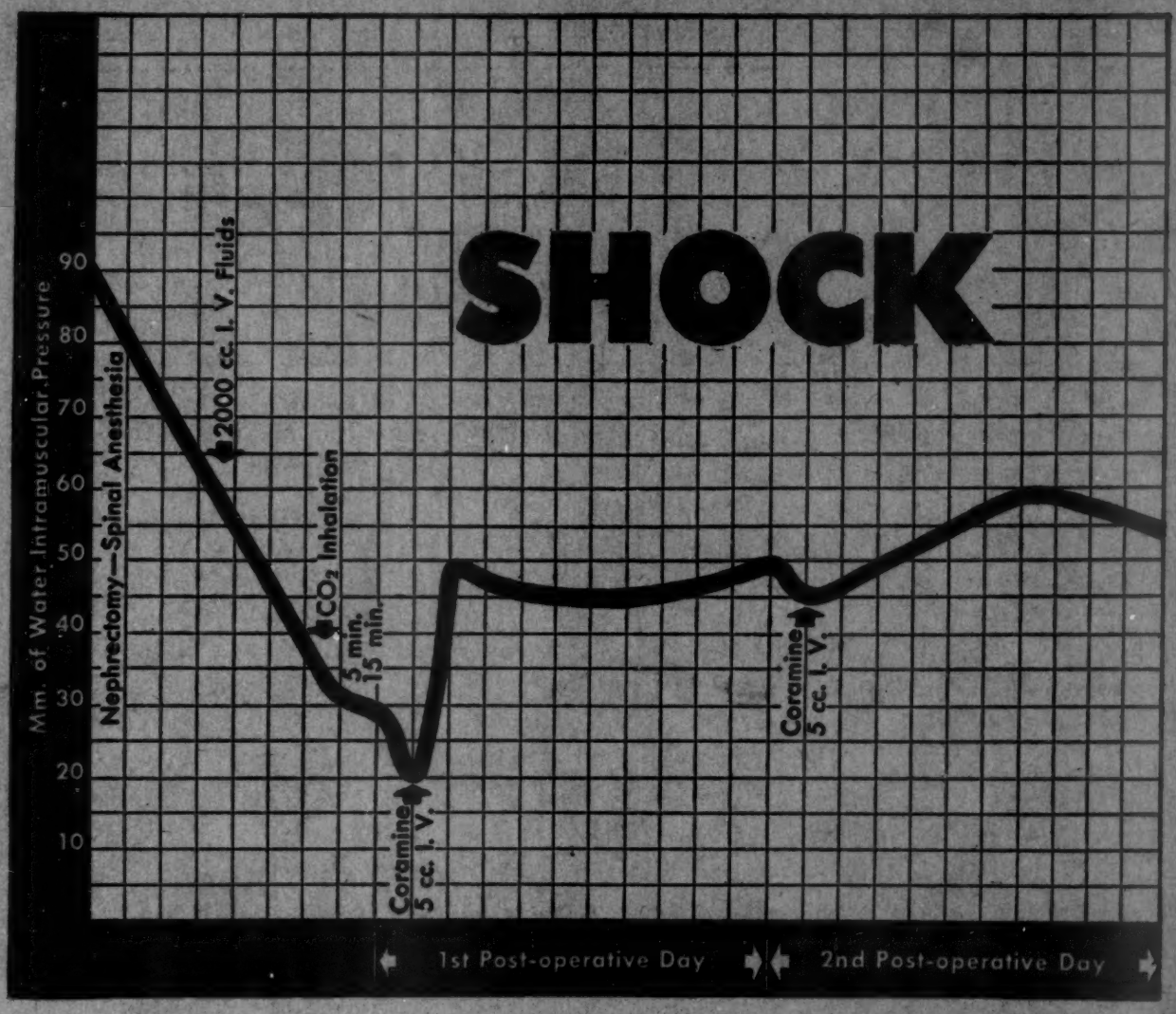
Abbott Laboratories	12
Alba Pharmaceutical Co., Inc.	*May*
American Hospital Supply Corp.	14
Arlington Chemical Co.	*May*
The Armour Laboratories	*May*
Ernst Bischoff Co., Inc.	32
Ciba Pharmaceutical Products, Inc.	*4th Cover*
Cutter Laboratories	*May*
E. Fougera & Co., Inc.	20
Hoffmann-La Roche, Inc.	5
Hynson, Westcott & Dunning, Inc.	*May*
The Lavoris Company	*May*
Lederle Laboratories, Inc.	*May*
Thos. Leeming & Co., Inc.	1
Eli Lilly and Company	*May*
The S. E. Massengill Company	22
Merck & Co., Inc.	*May*
The Wm. S. Merrell Company	16, 17
National Drug Co.	19
Ortho Products, Inc.	36
Parke, Davis & Co.	*May*
Petrogalar Laboratories, Inc.	18
Rare Chemicals	*May*
Schering & Glatz, Inc.	*May*
Schuylkill Chemical Co.	*May*
E. R. Squibb & Sons	15
Frederick Stearns & Company	13
The Upjohn Co.	*May*
Wallace & Tiernan Products, Inc.	21
William R. Warner & Co., Inc.	27
White Laboratories, Inc.	23, 33
Winthrop Chemical Co., Inc.	2
John Wyeth & Brother, Inc.	30

Hospital Supplies

Bard-Parker Co., Inc.	*May*
Becton, Dickinson & Co.	34
Crescent Surgical Sales Co., Inc.	9
Cutter Laboratories	*May*
General Electric X-ray Corp.	*May*
Fred Haslam & Co., Inc.	29
Johnson & Johnson	24, 25
Macalaster Bicknell Company	6
Mallinckrodt Chemical Works	*May*
Massillon Rubber Co.	31
Picker X-ray Corp.	35
J. Sklar Manufacturing Co.	11
The Tower Co., Inc.	31

Post-Graduate Instruction

Cook County Grad. Sch. of Med.	28
N. Y. Polyclinic Med. School	28



SHOCK is a complex syndrome having many causes and presenting many symptoms. Recent research[1] has demonstrated that in post-operative and post-anesthetic shock *intramuscular pressure drops before venous pressure fails.* This intramuscular pressure is of greatest importance in maintaining peripheral circulation and venous pressure is returned to normal by a restoration of intramuscular pressure.

CORAMINE,* of all the drugs tested, was found to promptly and spectacularly increase intramuscular pressure to normal. It was used intravenously in doses of 5-10 cc.

[1]Gunther, Lewis, Engelberg, Hyman and Strauss, Ludwig., INTRAMUSCULAR PRESSURE, Am. J. Med. Sci., 204, 265-283, Aug., 1942.

CORAMINE

COMBATS SHOCK

AMPULS **LIQUID**

*Trade-Mark Reg. U. S. Pat. Off.

CIBA *Pharmaceutical Products, Inc.*

SUMMIT, NEW JERSEY